SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

SAN FRANCISCO BAY AREA

Volume II

Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project

ABAG
ASSOCIATION OF BAY AREA GOVERNMENTS

BAY AREA
SOLID WASTE MANAGEMENT
IMPLEMENTATION PROJECT

VOLUME II

ENVIRONMENTAL EVALUATION FOR THE BAY DELTA
RESOURCE RECOVERY DEMONSTRATION PROJECT

A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.

eip

In association with Frank Stead

ABAG ASSOCIATION
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16. Abstracts This document is Volume II of a three-part report to ABAG. This report documents the planning conducted for the Bay Delta Resource Recovery Demonstration project. This proposed project would demonstrate recovery of resources from urban wastes and the use of composted refuse for island reclamation in the Sacramento-San Joaquin Delta. The report presents original research on the use of compost as a levee strengthening material and documents the planning for an intergovernmental structure to manage the demonstration, and serve as a first step towards eventual regional management of solid wastes. The report is published in three volumes, as follows:

Vol. I: Project Report
Vol. II: Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project
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[illegible], President

December 14, 1973

Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

Hans A. Feibusch, P.E. and Frank M. Stead

VOLUME II

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I. INTRODUCTION

The Bay Delta Resource Recovery Demonstration Project is an outgrowth of the 1971 SPUR report entitled, "A Solid Wastes Management System for the Bay Region." That report called for regional management of solid wastes, maximum recovery of resources from the solid waste stream and a proposal to use the organic portion of municipal refuse for island reclamation in the Sacramento-San Joaquin Delta. A pilot scale demonstration project was recommended to test this proposal. Subsequently, an Action Committee was formed under the sponsorship of ABAG (Association of Bay Area Governments) to obtain funding to conduct preliminary planning for the Demonstration. In February 1973 an EPA grant matched by local funding was obtained to conduct this planning study.

This report is an environmental evaluation of the preliminary design for the Demonstration that was developed in the planning study. Since a formal agency has not yet been established to sponsor the project and funding has not yet been obtained for final engineering design, this report is not presented as a legal environmental impact report. However, it follows the state CEQA guidelines for environmental impact reports and can serve as the basis for an EIR once the project reaches a final state of definition.

The Demonstration is temporary and would be conducted on a small scale--approximately 1,800 feet of levee would be treated over a two-year period. The project is designed to monitor the effects of land reclamation with composted refuse and sludge so that environmental questions can be answered before program implementation on a full-scale basis. Therefore, this report primarily addresses the specific impacts of the Demonstration. However, secondary impacts could result from activities stimulated by the successful completion of this project. These secondary impacts are discussed in Sections IX and XI.

The Demonstration would be sited at three primary locations--Berkeley, Sierra Point in South San Francisco and Mandeville Island in San Joaquin County. This report evaluates activities in all three locations.

II. SUMMARY

The Bay Delta Resource Recovery Demonstration is a two-year project designed to test resource recovery from municipal solid wastes and the use of the recovered and processed organic fraction for land reclamation in the Sacramento-San Joaquin Delta.

Refuse in Berkeley and San Francisco would be processed to recover metals and possible glass, and organic wastes would be composted in each city to produce a relatively stable humus product. About 100 tons per day of compost would be produced at each site and barged weekly to Mandeville Island in the central Delta.

Compost would be placed against an 1,800-foot section of levee in a berm extending 500 feet inland. The berm would buttress the levee and provide a new soil surface to be used for agricultural production. The Demonstration would take place on a 20-acre portion of 5,500-acre Mandeville Island. Extensive monitoring would be conducted to determine the effects on levee stability, water quality, air quality, agricultural productivity and the biotic environment.

The Delta is one of the most valuable resource areas of California, comprising 500,000 acres of prime agricultural land on numerous, scattered islands. The 1,100 miles of narrow sloughs and deepwater channels are valued for recreation, commercial shipping, fishery resources and as domestic and industrial water sources for major portions of the state. The Delta islands are protected by levees which are subsiding at rates up to five inches per year and require constant maintenance. Since reclamation was begun around the turn of the century, over 100 levee breaks have occurred, some resulting in irretrievable loss of land areas such as Frank's Tract, Big Break and the west end of Sherman Island. If measures are not taken to strengthen these levees, the rest of the Delta similarly

could be lost in the decades ahead. In addition to loss of land, flooded, unreclaimed islands create vast adverse effects upon the Delta environment, including greater saltwater intrusion from San Francisco Bay degrading the water quality in the Delta.

Solid wastes, including sewage sludge in the Bay Area, are in most cases unprocessed and dumped in landfills around the perimeter of the Bay. This results in a loss of recoverable resources and often a removal of wildlife habitat and impairment to the quality of surrounding waters.

The Demonstration proposes to test a concept that, if implemented on a large scale, would contribute to the solution of both the solid waste disposal and Delta land subsidence problems. There are potential adverse environmental effects of this concept, however, which would be investigated in the Demonstration.

The environmental evaluation conducted in this study indicates several areas of environmental concern. One of these is levee cracking and possible levee breachment due to the weight of the compost berm. Measures are offered to mitigate this effect, including a drainage system beneath the berm and field observations of pore pressures, settlements and horizontal movements. Another area of concern is the quality of the compost leachate at the composting sites and at the island. While leachates from compost are expected to be much less polluting than from raw refuse, the disposition of compost will be in a delicate estuarine environment rather than a sealed landfill.

Because compost has never been used as an engineering material, and because little research has been conducted on the quality of compost leachates, these preliminary investigations can only point to problem areas. Field research and laboratory analysis as proposed in this Demonstration will be required to establish definitive answers to these questions.

It is expected that the environmental impacts of the Demonstration itself will be minimal due to its limited scale and the extensive concurrent monitoring programs that would be conducted.

III. PROJECT DESCRIPTION

A. LOCATION

The Demonstration involves the processing of solid wastes in two urban areas, the transport of compost by barge to the Sacramento-San Joaquin Delta, and the reinforcement of a test section of levee on a Delta island. The project location is shown at a state and regional scale in Figures 1 and 2.

In Berkeley, a transfer station would be built in the industrial area of town just east of Interstate 80. The exact location of the site has not yet been determined by the city; however, the area being considered is shown in Figure 3. Shredded refuse from this facility would be delivered to a composting site at the Berkeley landfill. The landfill is a 40-acre site owned by the City of Berkeley and operated by a private company under contract. The specific composting site is a four-acre section of filled land at the northeast corner, approximately 12 feet above mean high tide in elevation. The coordinates of this site are 122° 19' 03" west and [illegible] 52' 28" north.

In San Francisco, refuse would be processed at the existing transfer station located west of the Bayshore Freeway on the San Francisco-San Mateo county line (Figure 4). This facility, owned and operated by Solid Waste Engineering and Transfer Systems (SWETS), was built in 1970 to process San Francisco refuse for transfer to a sanitary landfill in Mountain View. Processed refuse for the Demonstration would be delivered from this facility to a composting site on a 25-acre tract of land at Sierra Point. About five acres would be needed for the composting operations. This land, owned by the Sanitary Fill Company, is within the city limits of South San Francisco at coordinates 122° 23' 02" west and 37° 40' 27" north. The property is located east of the Bayshore Freeway and is bounded on the north by the Brisbane-South San Francisco city line. Situated about 10 feet above mean high tide,

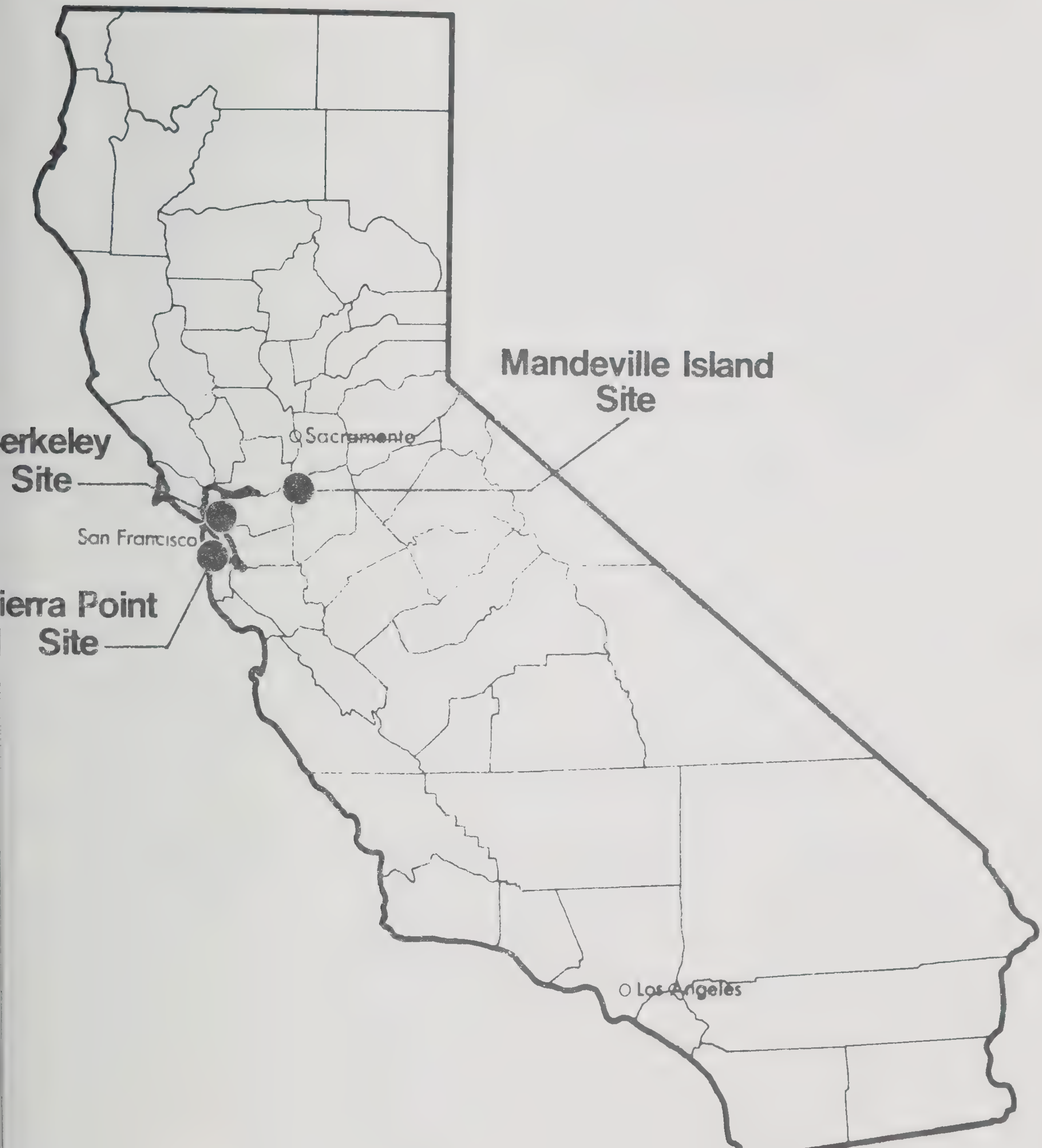
the site is adjacent to a shipping channel used by the American Bridge Division of U.S. Steel. Access to the property is by an easement granted by the California Division of Highways and Southern Pacific Railroad.

Compost produced at each site would be loaded into a barge docked in the adjacent waterway and transported through San Francisco, San Pablo and Suisun bays, up the San Joaquin River and finally delivered to the southeastern end of Mandeville Island. Centrally located in the Sacramento-San Joaquin Delta, Mandeville Island is bounded on the west by Frank's Tract and Quimby Island, on the south by Bacon Island, on the north by Venice Island, and on the east by Medford Island and McDonald Tract (see Figure 5). Surrounding waterways are Old River, the San Joaquin River, Middle River and Connection Slough. The test site for the Demonstration is a 20-acre parcel of land at coordinates 121° 31' 08" west and 38° 00' 06" north. The site fronts along 2,000 feet of levee and extends inland about 500 feet from the levee crown.

B. OBJECTIVES

The major objective of the Demonstration is to determine the feasibility of a regional solid waste management program that would recover resources from urban wastes and simultaneously reinforce levees and improve agricultural land in the Sacramento-San Joaquin Delta. Specific project objectives are:

1. Demonstrate regional cooperation in conducting a solid waste project.
2. Demonstrate the technical and economic feasibility of recovery of resources from solid wastes.
3. Determine the engineering feasibility of levee reinforcement with composted urban refuse.
4. Demonstrate the agricultural worth of new soil built from composted refuse.
5. Determine the environmental effects, especially on air and water pollution, of placing compost on a Delta island.



California Location Figure 1

Bay Delta Resource Recovery Demonstration Project

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Regional Location

Figure 2

Bay Delta Resource Recovery Demonstration Project

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Berkeley Site **Figure 3**

Bay Delta Resource Recovery Demonstration Project

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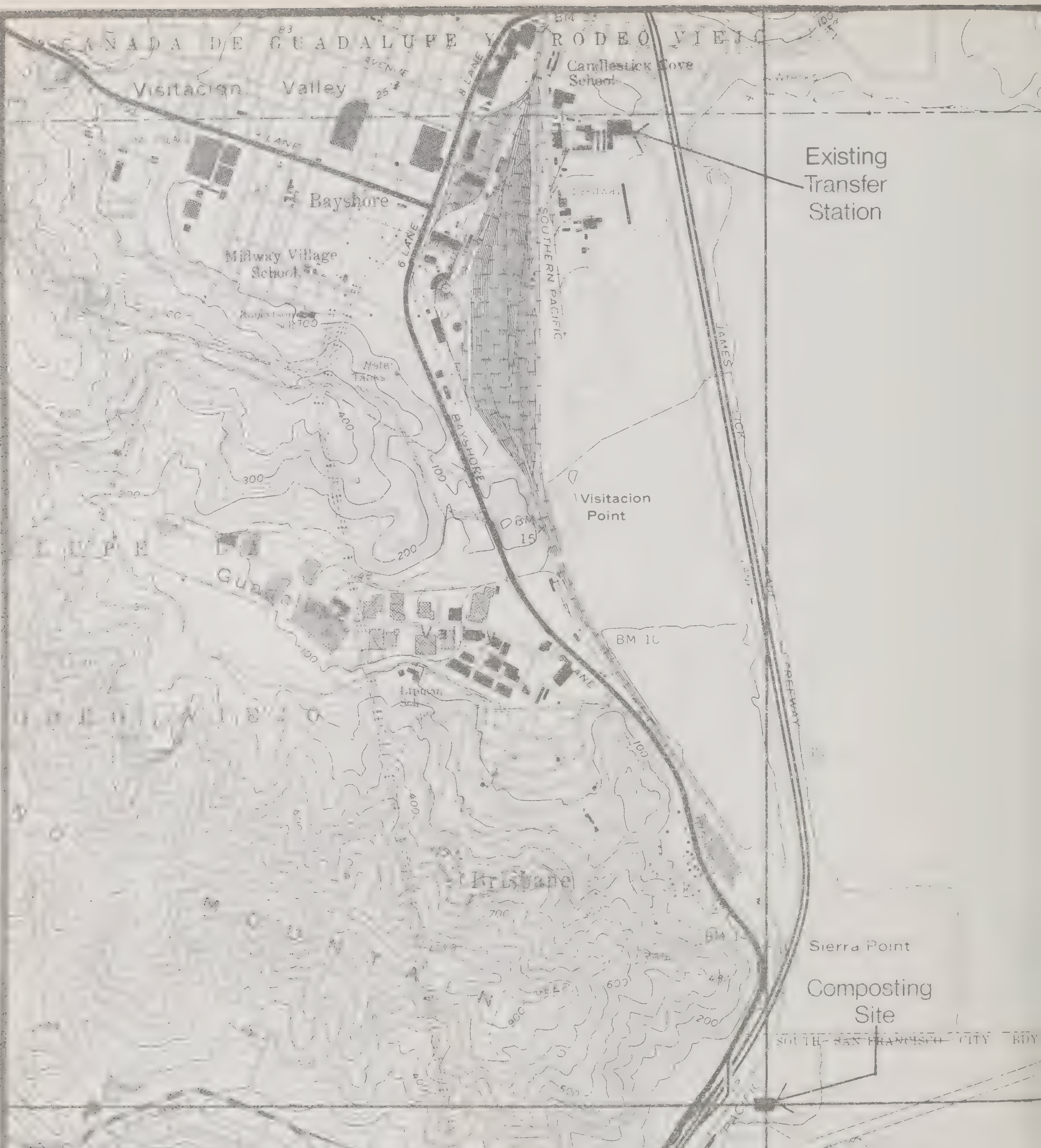

Sierra Point Site

Figure 4

Bay Delta Resource Recovery Demonstration Project

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C. OPERATIONAL DESCRIPTION

1. Processing and Resource Recovery

In Berkeley all refuse collected by municipal route trucks would be delivered to a transfer station for processing. This would total about 150 tons per day (46 truckloads, five days per week). An arrangement has been made with Oakland Scavenger Company to deliver an additional 50 tons per day should it be necessary for the Demonstration. The final design and layout of the transfer station will be developed as part of the Demonstration, but the following preliminary design offers a concept of the operation.[1]

The transfer station should have sufficient floor space for storing one day's refuse. The incoming material would feed into a shredding mill to reduce particle size to between two and six inches. The output of the mill is fed into an air classifier to separate the light material from the heavy fraction. The light material, estimated to be 85% of the total, consists mostly of paper and other organics and a small percentage of light plastics, such as polyethylene film. Approximately 125 tons per day of this material would be conveyed into self-unloading transfer trucks for delivery to the composting site at the Berkeley landfill. The heavy fraction, consisting of metals, glass, rubber, leather and heavy plastics, would pass through a magnetic separator to remove ferrous metals such as tin cans. About 5% of the input refuse (7.5 tons per day) is expected to be ferrous metal which can be sold for remelt to the steel industry. About 15 tons per day of the heavy fraction would remain, and it is unlikely that the small volume of metals and glass could be recovered economically. The heavy fraction that is not recovered for recycling would be disposed of at the Berkeley landfill.

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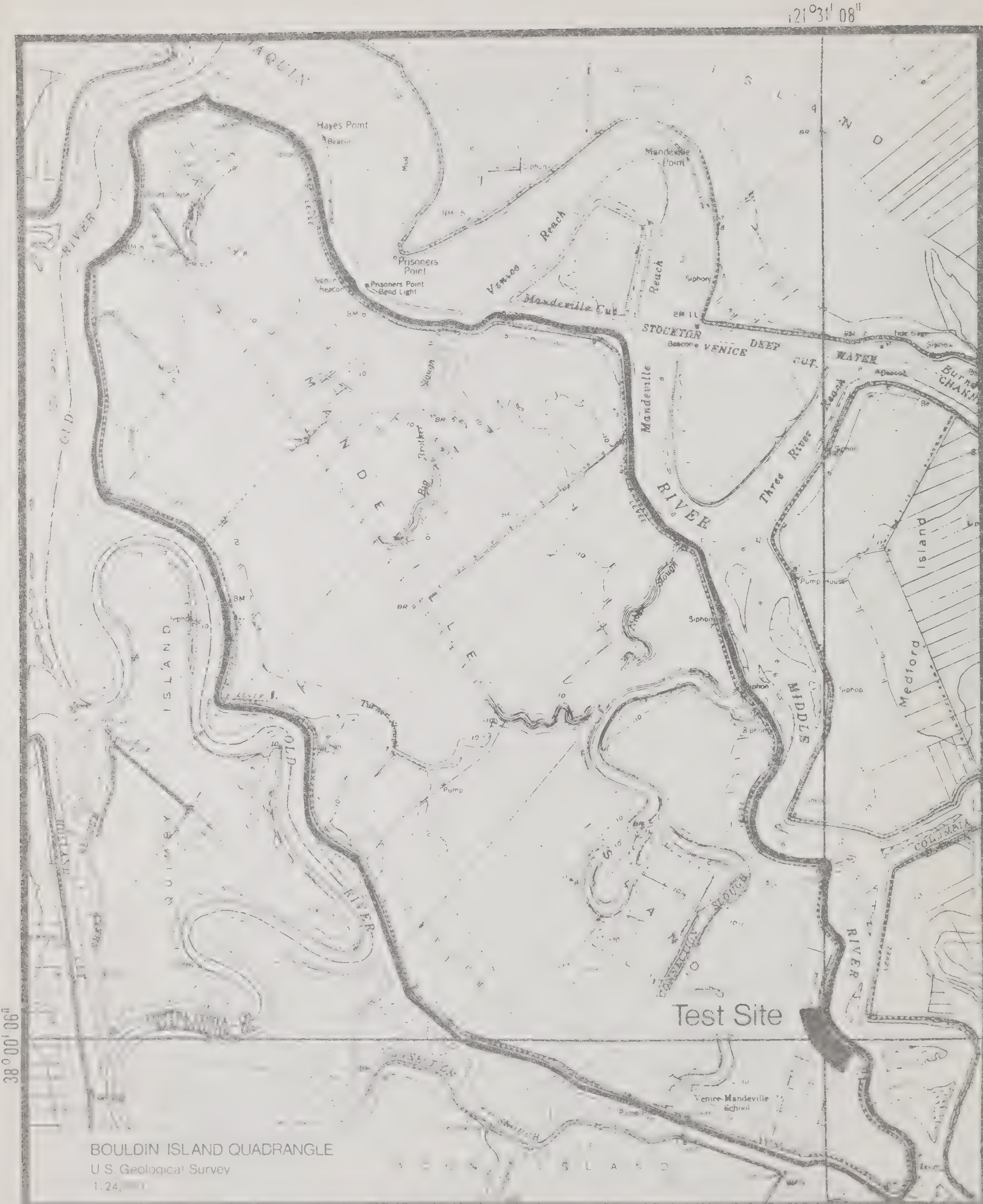
[1] Newspaper recycling in Berkeley is accomplished by an ongoing program of householder separation and monthly collection and is not considered as part of the Demonstration project. Newspaper separation improves the carbon:nitrogen ratio of the remaining refuse for composting and is recommended to the maximum possible extent.



Mandeville Island Site **Figure 5**

Bay Delta Resource Recovery Demonstration Project

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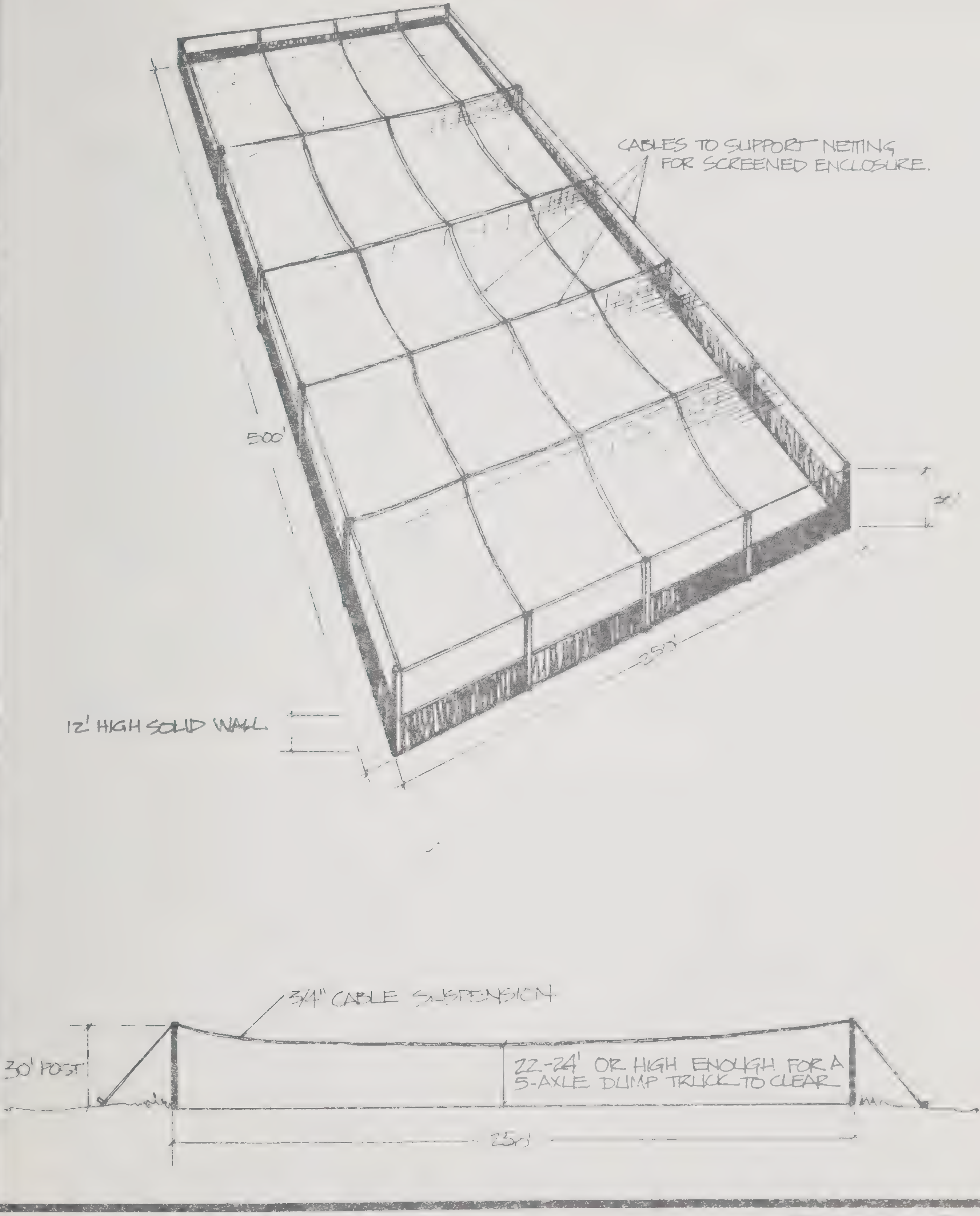

Composting Yard

Figure 6

Bay Delta Resource Recovery Demonstration Project

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In San Francisco, 150 tons per day of shredded, air-classified organics would be obtained from the existing transfer station.[1] This station currently receives 2,000 tons per day of municipal refuse, about one-half of which is from residential collection. The residential refuse is delivered to one side of the building and passed through a hammer mill for rough shredding followed by magnetic separation of ferrous metals. An economic feasibility study of further resource recovery is currently being conducted under an EPA grant. If the study proves positive, then the operators of the station would install their own equipment for further shredding, air classification and recovery of aluminum and other non-ferrous metals and possibly glass. Of the light organic fraction from the air classifier, 150 tons per day would then be diverted for use in the Demonstration. If the study indicates the economic infeasibility of installing this resource recovery equipment, then the Demonstration would require the addition of a small shredding and air classification operation to the transfer station to produce the 150 tons per day of shredded organics. In either event, the material would be loaded into self-unloading vehicles for transport to the composting site at Sierra Point, about two miles away.

2. Composting

Composting is the high-speed decomposition of organic wastes to render a relatively stable, dark-brown humus product. This is accomplished by mechanical processing to maintain proper environmental factors of moisture, aeration, temperature, pH level and carbon:nitrogen ratio. It is the control of these variables that distinguishes composting from natural decomposition which occurs in an open dump, a sanitary landfill or a manure heap. Many different types of composting systems have been developed in the United States and Europe to achieve stabilization of organic wastes. The system chosen in the preliminary design for the Demonstration is aerobic windrow composting.

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[1] As in Berkeley, newspapers are collected for recycling in San Francisco, and this operation is not included as part of the Demonstration project. Maximum source separation of newsprint is encouraged in San Francisco as well as in Berkeley.

At both the Berkeley and Sierra Point sites, up to 50 tons per day of vacuum-dried sewage sludge (20% solids) would be mixed with the organic refuse during the composting process. In Berkeley, sludge would be delivered by truck from the East Bay Municipal Utility District's secondary treatment plant in Oakland. At Sierra Point, sludge would be delivered from San Francisco's southeast sewage treatment plant, a primary treatment facility.

The composting operation would occur in a paved and enclosed composting yard. Shredded refuse and sludge would be mixed and formed into long piles called windrows. Machines would turn and moisten the windrows every few days to maintain aerobic conditions. Proper drainage should be provided to catch rainwater and leachate for recycling into the windrows so that no wastewater would be discharged from the operation. The yard can be enclosed with a cable-supported, wire mesh structure to contain any blowing shreds of paper (Figure 6). After several weeks of composting, the material would be screened to remove plastic film and oversize particles. The screened compost would then be trucked to the barge for transport to the Delta. Material not passing through the screen would require disposal at a landfill. Approximately 100 tons of screened compost per day would be produced at each site.

3. Transportation to Delta

Compost at each site would be loaded into a 600-ton barge docked in the adjacent waterway and shipped once a week to Mandeville Island. The preliminary design involves direct dumping by truck into the barge, as shown in Figure 7. Conveyor loading may also be considered in the final design. A 100-foot breakwater at the Berkeley loading site may be required to protect the loading facility.

Two barges would be needed for each site, one for loading and unloading at the composting site and the other for Mandeville Island. One tug would need to make one tow per week from each site. Figure 8 shows the transportation route from each composting site to the island.

The barge-unloading concept developed in the preliminary system design involves unloading at Mandeville Island by

a 35-ton truck crane mounted on a wharf. Compost would be removed by a clamshell bucket and loaded into a dump truck. The truck would drive onto a trestle extending into the island to dump the compost onto the island surface (Figure 9). Unloading by covered conveyors can also be considered in the final design.

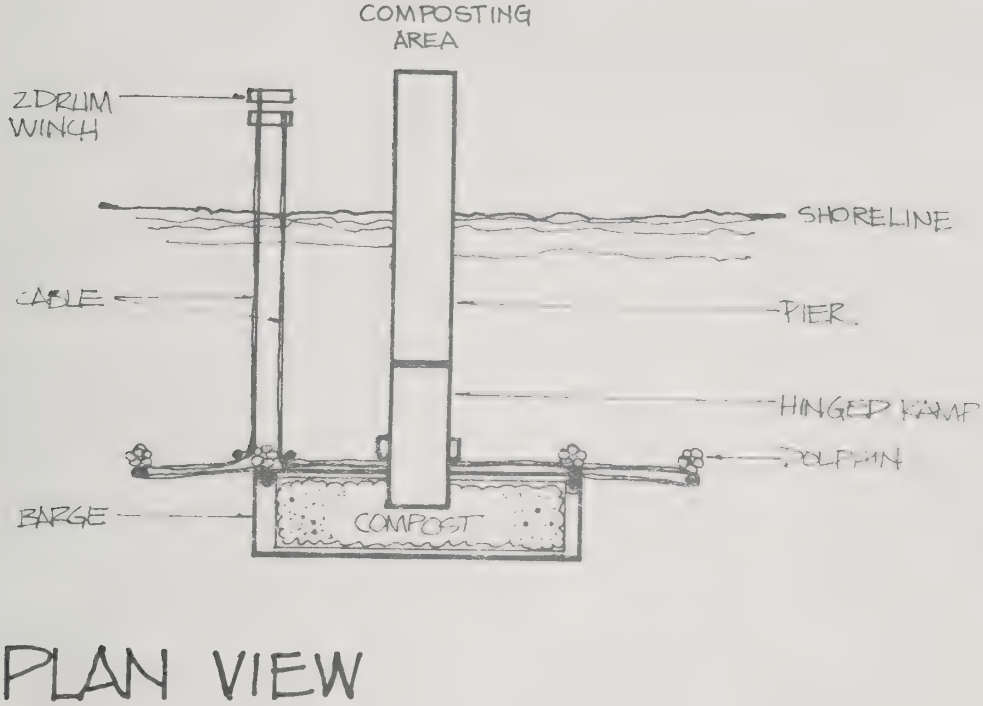
4. Compost Placement

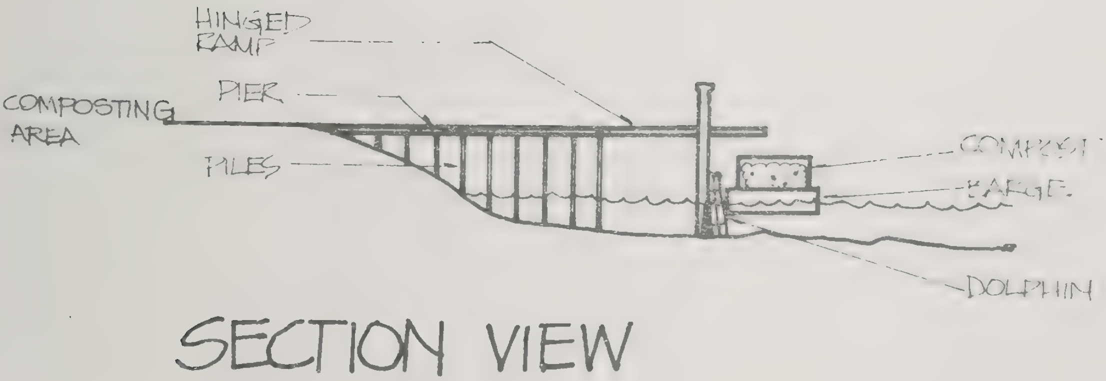
Compost delivered to Mandeville Island would be used to construct a berm behind a test section of levee. The purpose of the berm is to strengthen the levee against failure from high water pressures in the outside water channel and to raise the elevation of the land for improved agricultural practices. Figure 10 shows a cross-section of the levee test site. This site was selected based on available topographic and soils information. Before the berm is built, a topographic survey and a thorough program of subsurface exploration at the site should be conducted.

The berm would be built with a uniform slope of 25 horizontal to 1 vertical from the crest of the levee to the island floor. Since the levee is approximately 20 feet high, the berm would extend 500 feet inland from the levee crest. Compost would be moved from the base of the trestle to the placement area by a scraper vehicle and applied in wide, broad layers of approximately one foot thick. A crawler tractor would compact the compost to the required density. Before the compost is applied, a drainage system should be constructed to prevent water pressures from building up beneath the berm where seepage emerges from the levee and the adjacent ground.

Nonuniform settlement due to compression of the underlying peat would probably cause cracking of the levee, and repair of these cracks would be a necessary part of the construction operations. To prevent failures of the peat under the weight of the compost fill, the berm would have to be constructed slowly. All slopes, whether permanent or temporary, would have to be gradual. If the berm is built to the levee crest, approximately 1,800 feet of levee could be reinforced over a two-year period. Figure 11 shows the proposed completed compost berm.

An office trailer and graveled pad for vehicle parking would also be constructed at the site.





Barge Loading Concept

Figure 7

Bay Delta Resource Recovery Demonstration Project

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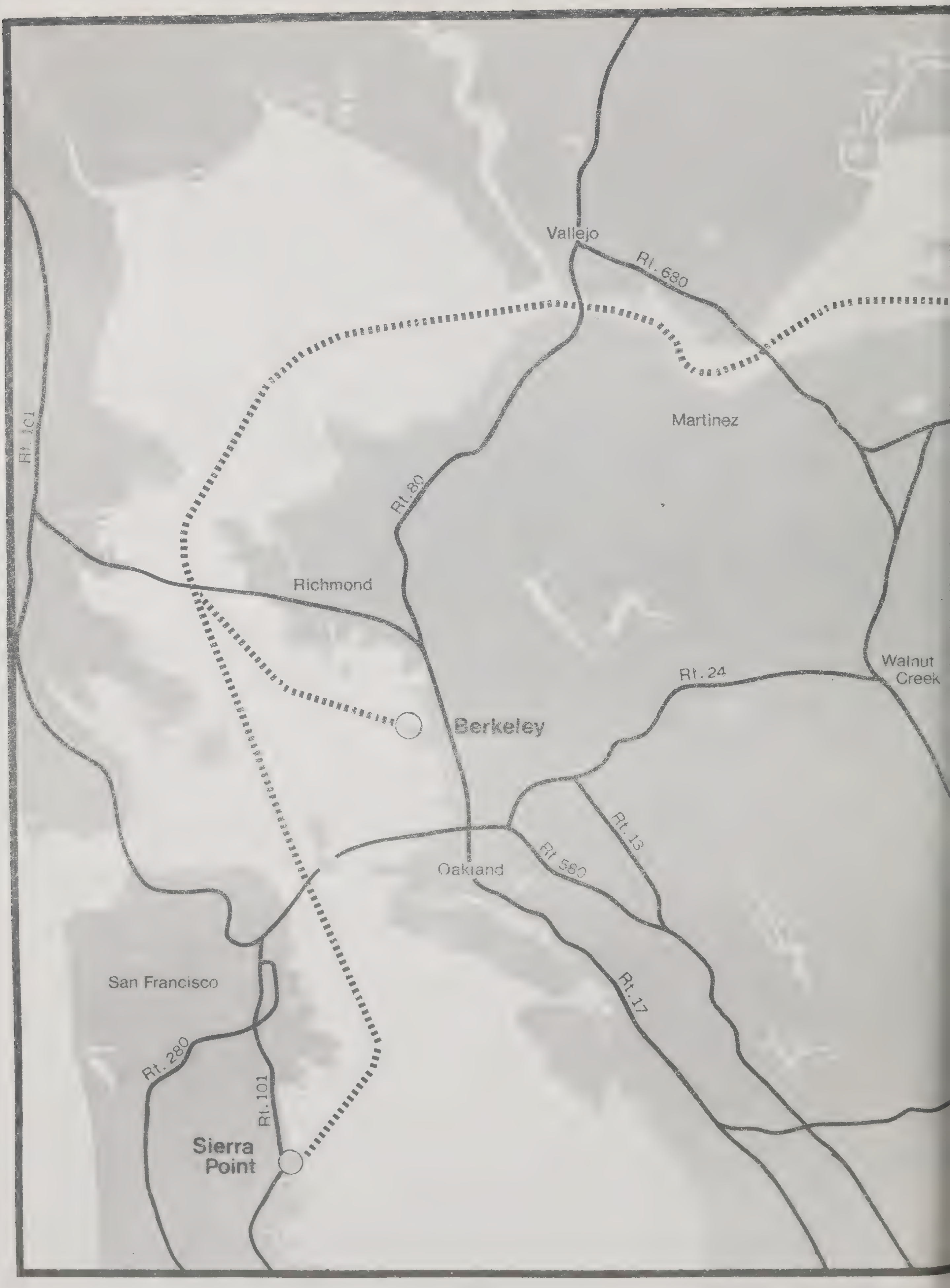
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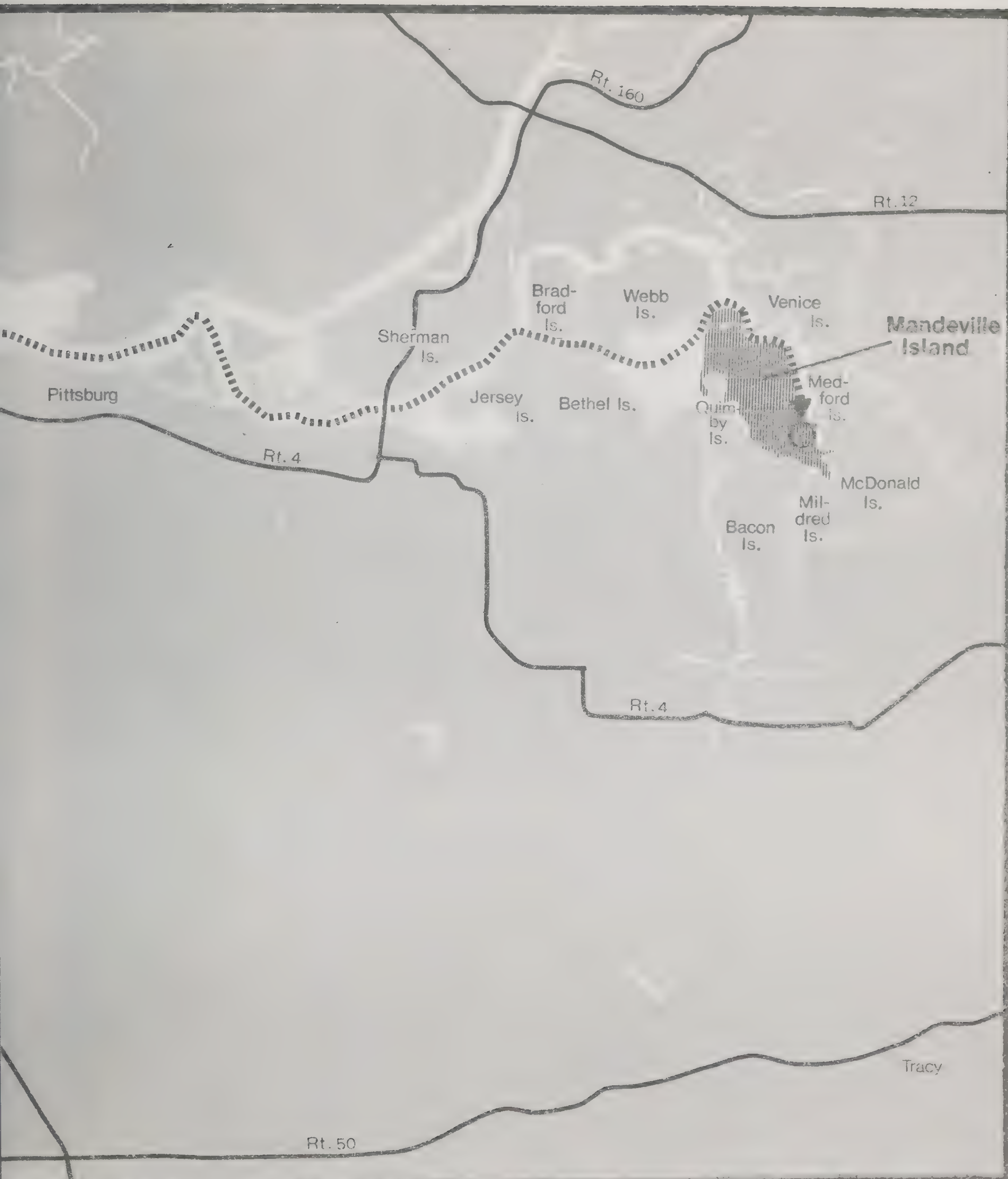

Transport Barge Route

Figure 8

Bay Delta Resource Recovery Demonstration Project

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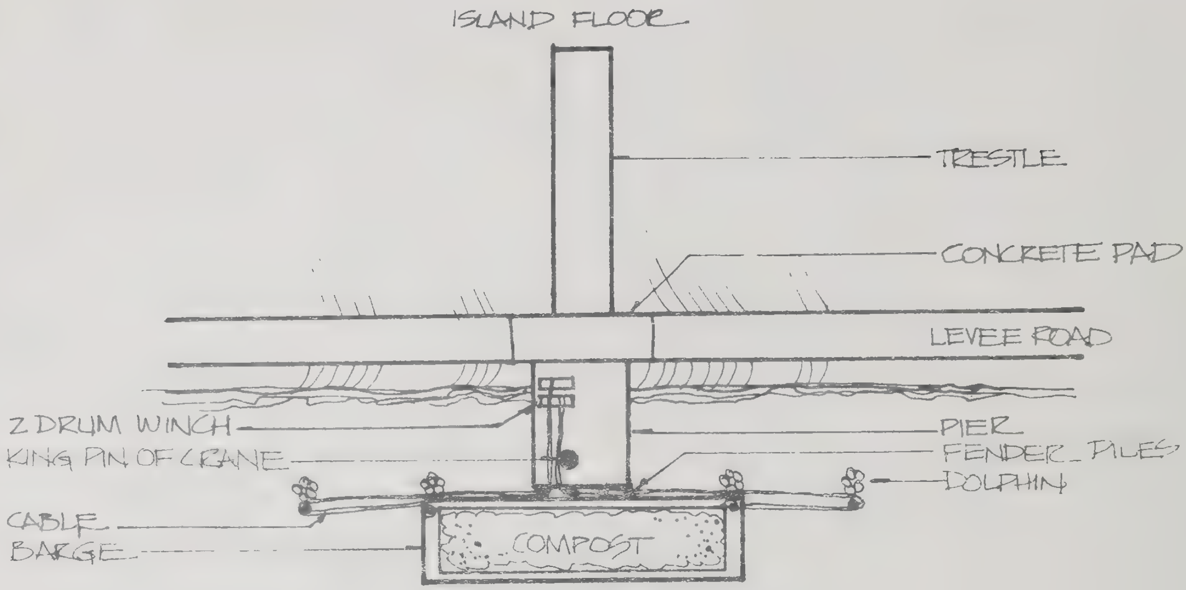
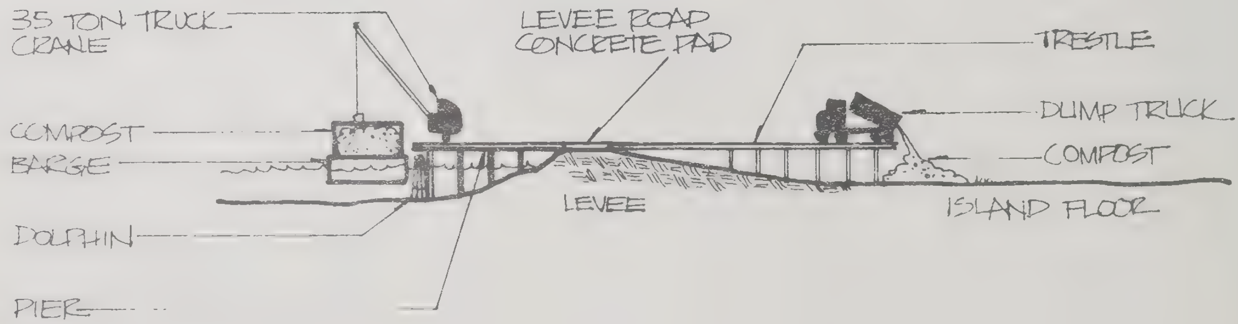


PLAN VIEW



SECTION VIEW

Unloading Barge Concept — Figure 9

Bay Delta Resource Recovery Demonstration Project

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5. Monitoring

Monitoring of air quality, water quality, soil stability and biotic impacts would be conducted to determine the environmental effects of the composting operation and the compost berm. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation. After emplacement, as the surface of the compost decomposes and weathers with time into a soil-like mantle, the agricultural productivity of the material would also be monitored to determine the agricultural worth of compost as a parent material base for the development of a new organic soil.

a. Water Quality

Water quality monitoring would involve three types of tests. First, tests would be conducted on the composting process itself. This would include sampling of both the solid material and leachate. Second, lysimeter tests would be conducted to determine the water pollution potential of the compost berm behind the levee. A lysimeter tank would be filled with compost to simulate the berm and would operate with either downward percolation of applied water or with complete saturation of the bottom layers. Third, full-scale site tests would be conducted prior to and during compost placement. A network of sampling points would be established to permit the sampling of applied water, drainage water and groundwater around the test levee site. These tests will furnish information on current water pollution levels to be used in comparison with the net increment imposed by the compost berm. Laboratory measurements of water quality would be grouped as follows:

(1) Toxicants (heavy metals, phenols, phthalates)

(2) Pesticides (chlorinated hydrocarbons, polychlorinated biphenyls--PCBs)

(3) Biostimulants (nitrogen, phosphorous)

(4) Oxygen-consuming potential (TOC)

(5) Pathogens (coliform)

(6) Mineral solids (electrical conductivity)

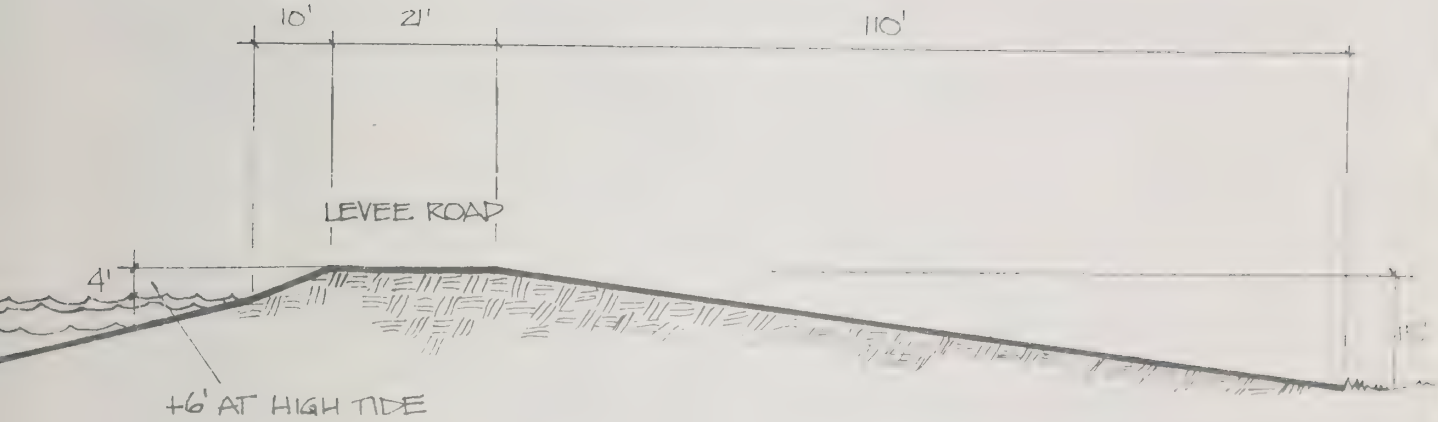
As the sludge and solid wastes from the two different sources may have considerably different properties, it may be useful to place the two composts at separate ends of the berm site to measure any differences in the quality of their leachate.

b. Air Quality

The purpose of air quality monitoring during the Demonstration is to investigate what effect the use of compost as a levee reinforcement material will have on the air quality of Mandeville Island and the Delta, both during the unloading and placement procedures and after the fill is in place and begins to weather into soil. Visual observation is the most realistic procedure for evaluating air quality during compost unloading, placement and compaction. Observation would be made under both mild to moderate winds (10 to 15 miles per hour) and under strong winds (15 to 40 miles per hour). Attention would be directed toward the wind erodibility of small bits of plastic film. After reinforcement of a section of levee is completed and the final surface attained, the surface is expected to slowly weather into a soil-like mantle. The wind erodibility of this developing surface can be compared with that of nearby peat soils by the use of simple impinger samplers placed at ground level.

c. Soil Stability

A number of field studies would be undertaken during the course of the Demonstration to monitor the affects of the berm. Settlements, horizontal movements and any spreading of the levee crest would be monitored carefully during the entire project. A thorough program of crack surveillance and repair would be continually conducted during and after construction.



NOTE:

GENERAL ISLAND ELEVATION IS ABOUT 18' TO 20' BELOW THE TOP OF THE DIKE.

Test Levee Cross Section Figure 10

Bay Delta Resource Recovery Demonstration Project

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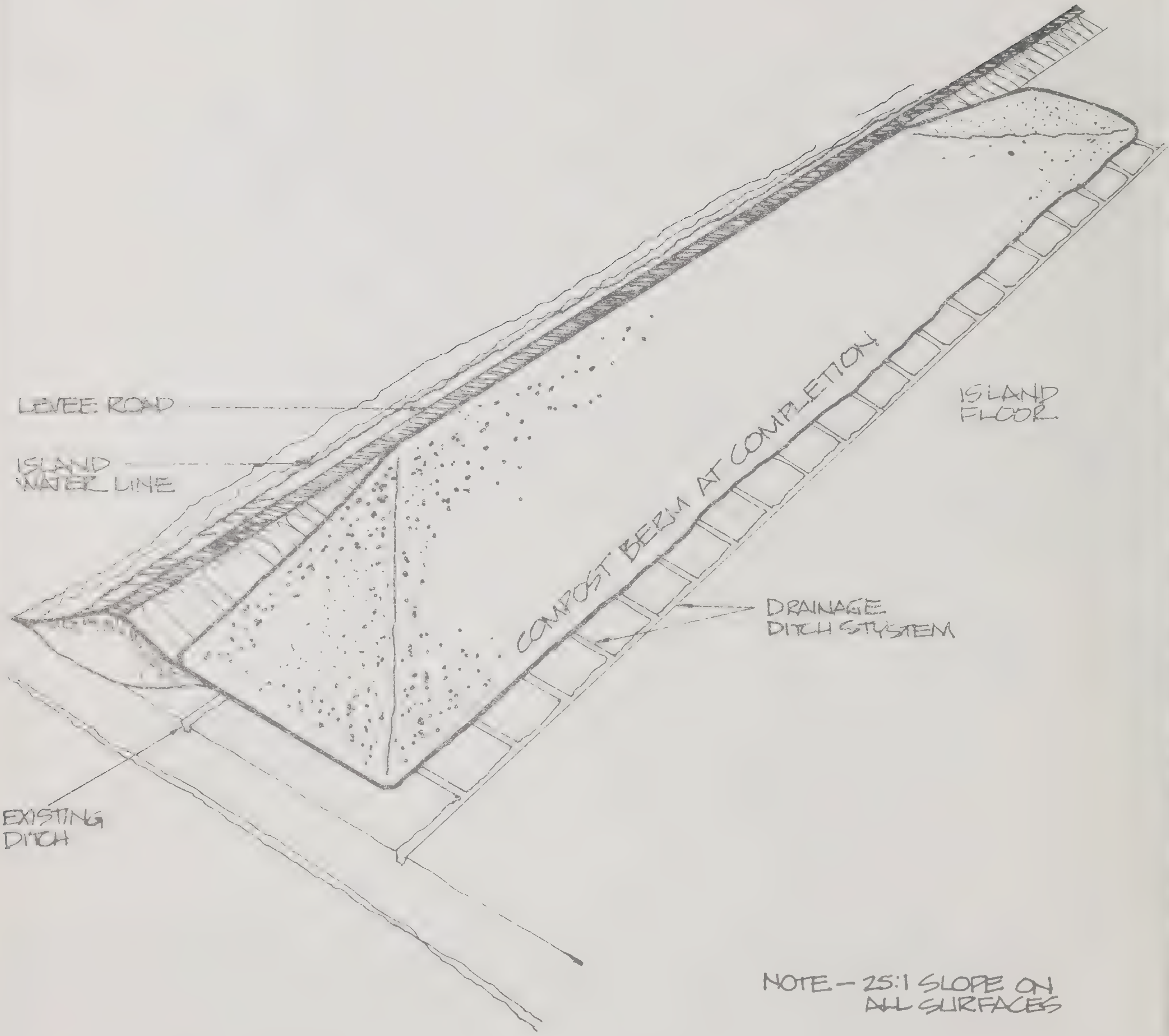

Compost Berm Concept

Figure 11

Bay Delta Resource Recovery Demonstration Project

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Piezometric (water pressure) levels in the drains and in the peat beneath the berm would be observed to insure that water pressures are maintained at low, safe levels by the drainage system. Densities and water content of the applied compost would be measured on a regular basis, and supervision would be provided to assure that the densities measured are representative of the entire fill. Permeability tests would be performed in the peat, the compost and the drain materials, using the falling head permeability procedure with standpipe piezometers. And finally, settlements within the berm and at the berm-peat interface would be monitored to check the accuracy of settlement predictions.

d. Agricultural Productivity

Agricultural productivity experiments would be conducted during the Demonstration in the lysimeters used for measuring the quality of compost leachate. The purpose of these experiments would be to obtain preliminary information on how compost behaves as an agricultural soil. In the first year, barley may be the only feasible crop and its yield would be depressed due to the high organic content of the material. Particular attention would be paid to plant toxicity due to possible uptake of heavy metals from the compost. Leaf analysis should also be conducted for possible concentrations of elements toxic to animals but not to plants (e.g., molybdenum, arsenic, selenium). The need for mixing Delta peat, dredged sand or fertilizer with the compost material, as well as irrigation requirements, would be investigated to obtain preliminary information for later field research. Once a section of test berm is built behind the levee, experiments would be initiated to determine crop response under field conditions and to determine proper agricultural practices on an elevated section of Delta land.

e. Biotic Effects

A comprehensive monitoring program would be conducted to provide data on the transportation of PCBs, phthalate acid esters, heavy metals and organochlorine residues from the compost material into the surrounding Delta environment. The monitoring must be initiated prior to

any deposition of compost material and be conducted for a period long enough to compensate for the time lag involved in the leaching processes. The program should be structured as follows:

1. Establish a number of monitoring stations in the vicinity of the test site to monitor pollutant levels of soil and sediment samples. Samples taken prior to the project will indicate the undisturbed background levels, and it is recommended that these samples be taken along transects at varying distances from the test site, and at a frequency adequate to permit reliable statistical evaluation of the data. Emphasis must be given to soil and sediments rather than to water, since the latter is known to be unreliable for the investigation of pollutant contamination levels in wildlife.

2. Determine prestudy and poststudy pollutant concentrations in a carefully selected animal "indicator" species. Samples of a single or several indicator species would be taken from downstream and upstream of the study site at frequent intervals to provide reliable data on the trends and the distribution of pollutants. The indicator species selected should be a resident (and not a mobile animal), one that can be easily collected (i.e., abundant), and preferably a filter feeder. Potential candidates include a mollusk, the Asiatic clam *Corbicula fluminea*, the crayfish *Pacifastacus leniusculus*, the mysid shrimp *Neomysis awatschensis*, or the amphipod *Corophium*.[1] The mysid shrimp is probably the ideal species, since it is a major food item of striped bass, American shad, green sturgeon, channel catfish, black crappie and warmouth.[2] Analyses based on highly mobile or predatory fish

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[1]California Department of Fish and Game, *Ecological Studies of the Sacramento-San Joaquin Estuary*, 1972.

[2]*Ibid.*

are not reliable because it is impossible to isolate the source of contamination. It is imperative that the sampling be statistically defensible and provide useful information on the ecological impact of any contaminants introduced by the compost.

3. By sampling, determine the daily input of pollutants contained in the sewage sludge and refuse to provide essential background data.

6. Economic Characteristics

The estimated cost of conducting the Demonstration is $6.9 million as shown in the following table.

PROJECT COST ESTIMATE

	(A) Capital Costs	(B) Annual Operating Cost	(C)=(A)+2(B) Total Cost
Processing/transfer station	$ 253,000	$ 162,000	$ 577,000
Composting	2,250,000	692,000	3,634,000
Barge transport	500,000	545,000	1,590,000
Compost placement	110,000	200,000	510,000
Monitoring	54,000	170,000	394,000
Project supervision		50,000	100,000
Other	25,000	25,000	75,000
	$3,192,000	$1,844,000	$6,880,000

The Demonstration would be sponsored and managed by an intergovernmental agency of Bay Area jurisdictions. This agency would be responsible for fund-raising, cost-sharing arrangements among members, and other management aspects of the Demonstration.

D. RELATIONSHIP OF THE DEMONSTRATION TO FEDERAL, STATE, REGIONAL AND LOCAL PLANS

1. Federal and State

The Demonstration is consistent with the Federal Resource Recovery Act of 1970 and State Senate Bill No. 5, both of which have three major common objectives:

1. The formation of intergovernmental entities to assume overall responsibility for solid waste programs and for equitable distribution of costs.

2. The formulation and adoption of comprehensive solid waste management plans on a regional or subregional level.

3. The requirement that solid waste management plans give maximum consideration to resource recovery.

One of the two major elements of the Demonstration is the establishment of a regional intergovernmental structure to carry out the physical demonstration and to formulate a method for equitable distribution of the costs. This element partially fulfills the objective for regional waste management plans by providing a component operation for such a plan and also by showing potential methods of initiating regional cooperation and agreements.

The physical plan, the Demonstration's other major element, is entirely dedicated to the principle of resource recovery. The Demonstration seeks to explore the feasibility of conversion of the organic component of solid waste to a composted material which could be used to restore or rebuild the earth's soil mantle. The primary emphasis would be on reinforcing the deteriorating levees of the Delta; however, the concept could be applied to land reclamation in other areas as well. Ferrous metal and possibly other resource recovery is also included in the Demonstration.

The Demonstration is also related to state plans outlined in "Delta Levees, What Is Their Future?"[1] This is a

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[1] California Department of Water Resources, _Delta Levees, What Is Their Future?_, September 1973.

discussion of alternative courses of action for the Sacramento-San Joaquin Delta levees. Four alternatives are outlined:

Alternative A - No improvement
Alternative B - Extensive improvement
Alternative C - Moderate improvement
Alternative D - Polders (dikes surrounding a group of islands)

The Demonstration is in conformance with the concept of reinforcement of the inner portion of the levee, as stated in Alternatives B and C. However, it does not address either recreational development, widening of levee roads, or improvement of the outside of levees.

2. Local

a. Berkeley

The Berkeley City Council has an existing policy to discontinue current landfill operations due to opposition to further bayfill.[1] For the past 18 months, it has been the responsibility of the City Council's Solid Waste Commission to find and investigate alternative methods of disposal. At their advice, the City Council on September 18, 1973, adopted a revised proposal to participate as a donor-city in the Demonstration. Their proposal includes the construction of a processing station and donation of land for the composting site.

The composting site on land reclaimed by the existing landfill operation in the northwest section of the Berkeley waterfront is planned as municipal recreational open space. Upon completion of the Demonstration, the composting site would be available for development as proposed and the transfer station and equipment could be operated and owned by the city as a component of their ultimate solid waste management system.

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[1]Conversation with Thomas Peak, Planning Director, City of Berkeley, November 6, 1973.

b. San Francisco

Currently, San Francisco's municipal wastes are disposed of by the Sanitary Fill Company (S.F.C.) at the Mountain View landfill site.

This site has a life expectancy of two years under the current contract with the City of Mountain View. S.F.C. is studying future alternative operations or sites. Their participation in the Demonstration is a small-scale experiment to investigate the feasibility of this method of solid waste management for possible future utilization.

The Sierra Point compost site, under the jurisdiction of the City of South San Francisco, is zoned M-1, Heavy Industrial Development. The Demonstration's use of the site would be in conformance with this designation and would be a temporary use.

c. Mandeville Island

Mandeville Island is under the jurisdiction of San Joaquin County and zoned EA-10, Exclusive Agricultural, 10-acre minimum parcel. It is classified as prime agricultural land by the adopted "Open Space Element" of the San Joaquin County General Plan.[1] The planning objective for this type of land is "To preserve in agriculture those lands suitable for various agricultural uses."[2] It further states, "A major objective of planning open space in an agriculturally prominent county is to preserve and enhance this important segment of the economy and to identify and protect the resources upon which it is based."[3] The Demonstration appears to be in direct compliance with these planning objectives.

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[1]Cities and County of San Joaquin Advisory Planning Association, Open Space Element, June 27, 1972, p. 21.

[2]Ibid.

[3]Ibid.

Mandeville Island is also in the Delta Advisory Planning Council (DAPC) study area. At this time, DAPC is preparing its Preliminary Comprehensive Plan for the Delta. No definitive, adopted plans are available at this time.

E. JURISDICTIONAL BODIES AFFECTED

At all project locations, permit approval from various government agencies is required to help determine the feasibility of and requirements for the project. The Berkeley transfer station and composting operation fall under the primary jurisdiction of the Berkeley Services Department with input from the Planning, Public Works and Public Health departments. The Sierra Point composting site will require permit approval from the City of South San Francisco (the South San Francisco Planning Department requirements have not yet been confirmed). In addition, the U. S. Army Corps of Engineers will require permits for docking structures at both composting sites. The San Francisco Bay Regional Water Quality Control Board and the Bay Conservation and Development Commission will also require permit approval at both compost sites.

The San Joaquin County Planning Department has primary jurisdiction over the Mandeville Island test site with review by the Public Works and Public Health departments. The Corps of Engineers would require a permit for the docking structure; and the Central Valley Regional Water Control Board would review for approval the water pollution aspects of the Demonstration, possibly setting waste discharge requirements. Approval from the State Reclamation Board with an endorsement from the local board may be required.

Upon receiving applications, these agencies normally refer to other agencies for review and recommendation. Diplomatic review would come from various agencies including the following:

- State Air Resource Control Board
- State Lands Commission
- State Department of Fish and Game
- State Bureau of Mines and Geology
- State Navigation and Ocean Development Department
- State Conservation Department
- Federal Bureau of Wildlife and Conservation
- Association of Bay Area Governments
- Delta Area Planning Council

IV. ENVIRONMENTAL SETTING

A. DELTA REGION

1. General Description

Mandeville Island, site of the project's compost placement operation, is one of the more than 50 islands and reclaimed tracts that comprise a major portion of the Sacramento-San Joaquin Delta. The Delta is a triangular-shaped area of approximately 740,000 acres (waterways amount to 50,000 acres) lying at the confluence of the Sacramento and San Joaquin rivers. These two rivers drain 37% of the land area of California and handle almost 47% of the natural runoff of the state. The Delta stretches from Sacramento on the north, Stockton on the east and Antioch on the west (see Figure 2).

Until large-scale reclamation began in the late 1800s, the Delta was a vast, shallow inland sea, with extensive tule growths covering deposits of peat. Reclamation was begun to provide agricultural land to feed California's increasing population during the Gold Rush of the 1850s. Reclamation involved construction of levees and draining of the enclosed lands. Currently there are over 1,100 miles of levees in the Delta, the result of over 100 years of reclamation.

The entire Delta--with the exception of the Montezuma Hills north of the Sacramento River and some areas along the south bank of the San Joaquin River east of Antioch--is approximately at mean sea level. Due to land subsidence, most of the islands and tracts of the Delta actually lie from 5 to 20 feet below mean average sea level and are maintained by levees. The Delta is a unique environment in California with its below-sea level islands and complex, interconnecting system of waterways, sloughs and deepwater channels. Because of its distinctive topography and visual quality, the Delta has been nicknamed "Netherlands of the West."

2. Geology and Soils

Geologically, most of the Delta has been formed from alluvial materials deposited by periodic flooding of major streams and is of the recent Quaternary period. The peat soils that exist over these deposits are the result of the partial decomposition of the surface of peat deposits built up over the past 10,000 years from extensive vegetative growth that existed between river channels prior to reclamation. Principal plants forming the peat are tule or bulrush (*Scirpus* species), common reed (*Phragmites communis*) and cattail (*Typha* species). Gradual increases in sea and river level and continued geologic subsidence have permitted the peaty layer to accumulate to a depth of as much as 50 feet in several places. Peat soils are highly organic and very productive agriculturally. They comprise about 150,000 acres of the Delta. The highly organic soils of the Delta are Correra, Staten, Venice and Egbert peat soils. Other types consist of associated soils in which advanced alteration and an admixture of mineral soils have played an important role.[1]

3. Land Use

The Delta is one of the most valuable resource areas of California. It has four major uses: agriculture, recreation, fishing and shipping.

Agricultural production in 1970 was estimated at over $140 million.[2] Principal Delta crops are asparagus, tomatoes, sugar beets, potatoes, sunflower, safflower, corn and small grains, with limited fruit and grape harvests.

The Delta supports some of California's greatest fishery resources. It is an important spawning ground and

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[1] Stanley W. Cosby, *Soil Survey of the Sacramento-San Joaquin Delta Area, California*, Series 1935, No. 21.

[2] California Department of Water Resources, *Preliminary Report to the California Legislature on a Multiple-Purpose Levee System for the Sacramento-San Joaquin Delta*, February 1970.

migration route for anadromous fish. It also provides habitat for resident game fishes such as catfish, black bass and crappie and is a vital food source of zooplankton, shrimp and benthos--i.e., clams, worms and insects. An ocean commercial salmon catch of over eight million pounds annually is supported by migration through the Delta to the Sacramento and San Joaquin rivers.[1]

Recreational use, with a resident population of over four million within a one-hour drive of the Delta, is estimated to be 5.7 million recreational user days in 1973. The primary recreation activity is fishing, followed by pleasure boating.[2]

The Delta channels, particularly the Sacramento and San Joaquin rivers, are used for commercial shipping from the ports of Sacramento and Stockton. About 7,500,000 tons of cargo annually move through the Delta waterways.[3] The Sacramento-San Joaquin Delta also serves as a source of domestic and industrial water for Contra Costa and Solano counties.

4. Air Quality and Climatology

The Delta area--with hot, rainless summers and cool, moist winters--has a Mediterranean type of climate. The cooling ocean breezes blowing inland through the Carquinez Straits usually reduce summer temperatures in the Delta to below those of other parts of the Central Valley. Because of this, most of the Delta may be considered the cool Mediterranean subtype (Csb) of Köppen's classification.[4] The mean annual temperature is about 60°F (18°C).

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[1] California Resources Agency, Water Development and the Delta Environment, Report No. 7, December 1967.

[2] Delta Master Recreation Plan Task Force, Delta Master Recreation Plan, February 1973.

[3] California Department of Water Resources, Preliminary Report.

[4] Vladimir Köppen, Die Klimate Der Erde (Berlin, 1923).

The range is from 45°F to 50°F (4°-5°C) for the winter months and 70°F-75°F (21°C-22°C) for the summer months. During winter months, the presence of large, open bodies of water combined with low elevation present excellent conditions for the formation of fog. The "tule" fogs of the Delta may last for weeks and are known for their density.[1] The mean annual rainfall in the Delta depends on location. A maximum of approximately 14" of precipitation occurs in the central and eastern sections, while a minimum of 10" occurs in the southern part. Mt. Diablo, which blocks the prevalent winds from the southwest, causes this lower precipitation zone. Over 50% of the area's precipitation occurs during the winter with spring and fall months accounting for the remainder. Summer months are usually rainless.[2]

Air quality in the Delta is variable. In the winter months, air quality is generally good; however, significant concentrations of photochemical oxidant and suspended particulate matter are often recorded at the nearby air monitoring station at Pittsburg during the summer.

Photochemical oxidant is produced by the reaction of pollutants, mainly hydrocarbons and nitrogen dioxide with sunlight. Although these precursor pollutants are not produced in significant amounts in the Delta area, they are produced in large quantities in the highly urbanized and industrialized areas west of the Delta. Winds blowing through Carquinez Straits transport photochemical smog into the Delta area a significant number of days during the summer months. Concentrations of other pollutants such as carbon monoxide, sulfur dioxide and nitrogen dioxide seldom reach high values. Misuse of agricultural chemicals and pesticides occasionally cause air pollution problems of short duration.

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[1]Contra Costa County Planning Department, Land Use and Transportation Study, Inventory for the Conservation Element, August 1971, p. 78.

[2]U.S. Department of Agriculture, "Soil Map, Sacramento-San Joaquin Delta Area," 1935, p. 78.

Dust storms are a problem in the summer months, causing high values of suspended particulates. These dust storms generally occur in the afternoon when winds exceed 15 mph. Westerly winds prevail during the summer and spring, ranging from northwest to southwest, depending on location in the Delta. Fall and winter winds are more variable, with occasional strong northerly winds and southerly winds associated with winter storms.

5. Vegetation

The existing vegetation in the Delta is the result of almost total alteration of the extensive tule marshes that existed prior to reclamation. Small nonagricultural islands and the margins of the larger agricultural islands, where not denuded as part of levee maintenance procedures, still support growth of common tule and bull tule. Common tule is from three to nine feet tall and grows in both fresh and salt water. Bull tule is a shorter-growing tule, averaging one to three feet in height, and grows only in salt marshes or on moist alkaline soils.[1]

As a result of past reclamation activities, the aquatic vegetation of most islands has been replaced by salt grass, red top and other European grass introductions, in addition to a wide array of cultivated crops. Limited areas of natural vegetation scattered throughout the Delta consist primarily of streamside vegetation including willows, western sycamore and fremont cottonwood.

6. Wildlife

The Delta provides an invaluable habitat for migratory waterfowl on the Pacific Flyway and for a multitude of resident wildlife species; a total of some 16 species of ducks, 5 species of geese and 1 species of swan use the Delta area.

It has been estimated that an average of 10 million ducks and one million geese regularly winter in California, the majority using the Delta, Central Valley and San

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[1]Conversation with Mr. Jack Downs, special agent in charge of U.S. Bureau of Sport Fisheries and Wildlife, Sacramento office.

Francisco Bay areas.[1] Delta waterways and adjacent farmlands are classified as prime waterfowl habitat, and San Joaquin County consistently rates in the first ten in hunter bags of ducks and geese.[2]

Agricultural lands, in combination with surrounding riparian vegetation used as nesting areas, provide important food sources for pheasants, owls, quail, doves and songbirds, as well as for jackrabbits, cottontails and bush rabbits. Other common wildlife species found near waterways include the grey squirrel, badger, beaver, muskrat, mink, raccoon, river otter, grey fox and Columbian black-tailed deer.[3] Irrigation ditches extend the normal habitat for water-related and other species which would not normally live in a dry area.

7. Socioeconomic Setting

The Delta's economy is based primarily on agriculture. A secondary revenue source is from recreational use of the area. There are no large cities within the Delta, and most commercial and cultural activities are provided by Sacramento, Stockton, Pittsburg and Antioch. The only population centers within the Delta are Isleton (population 1,000) and Rio Vista (population 2,900).

Mandeville Island is part of U.S. Census Bureau Tract No. 39 which also includes Quimby, Bacon, Woodward, Victoria, McDonald, Medford, Coney, Fabian, Roberts, Mildred, and Rough and Ready islands, plus Lower Jones, Upper Jones and Hennings tracts.

1970 U.S. Census figures for Tract No. 39 indicate that it has a resident population of 3,246 people of which 47% are of Spanish surname, 66% of the male employed population are farm workers, the average education is limited to elementary school, and 51% are foreign born.

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[1]Suisun Soil Conservation District Final Report, Phase 1, Solano County, p. C-14.

[2]California Department of Fish and Game, California Fish and Wildlife Plan, Volume III, Supporting Data, Part A, Inventory (Wildlife and Island Fish), 1965.

[3]Conversation with Mr. Jack Downs, special agent in charge of U.S. Bureau of Sport Fisheries and Wildlife, Sacramento office.

Family size averages four persons and the average income is $8,234. Most of the residents live near enough to their work to walk rather than having to use private or public transportation.

8. Transportation

Major transportation routes to the Delta are Interstate 580 from the mid-Bay Area (Oakland); Interstate 5 from the north and south and State Highway 4 running east-west through the Delta from Stockton to north Contra Costa County. State Highway 160 parallels the Sacramento River from Antioch to Sacramento, while Highway 12 traverses the Delta from Rio Vista to Lodi and U.S. 99.

9. Special Problems

Special problems exist in the Delta which are the result of the unique origin, location and use of the area. These include levee instability, land subsidence and water quality problems, including saline intrusion.

a. Levee Instability

The majority of the 1,100 miles of levees in the Delta are placed on highly unstable peat soil foundations which are prone to failure under stress from high tides, erosive flood flows, wind- and boat-induced waves and seepage forces. In 1966, the Army Corps of Engineers identified over 200 miles of levees that were in some state of deterioration. Recreational use also aggravates the problem of levee instability by wave erosion and increasing traffic on levee roads.[1]

b. Land Subsidence

When exposed to air, peat soils of the Delta naturally oxidize into carbon dioxide and water and small amounts of soluble and insoluble inorganic materials. Agricultural operations speed up this natural oxidation process while reducing or eliminating the aquatic plants which are the source of peat. This phenomenon--coupled

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[1]California Department of Water Resources, Preliminary Report, p. ix.

with wind erosion, compaction due to agricultural equipment use,and burning--has caused an average annual subsidence of island surfaces of two to three inches, or between 15 and 20 feet of subsidence since reclamation began.

c. Water Quality

The water quality of the Delta is degraded by a number of factors. A salinity gradient (ranging from fresh to salt water) exists in the Delta which fluctuates seasonally and is dependent upon fresh water flow through the Delta. Saline intrusion occurs when the normal hydraulic barrier between saline Suisun Bay waters and the Delta is breached. The tidal action near Pittsburg and Antioch then forces saline waters into the Delta. These saline waters considerably degrade the water quality in the area. A recent example of a serious saline intrusion was the Andrus-Brannan Island flood of 1972.

The other specific water quality problem in the Delta results from agricultural drainage waters that are pumped into the waterways from the islands. These waters contain variable amounts of agricultural chemicals applied to the land in the form of fertilizers, soil amendments and pesticides, and mineral salts that are leached out of the soil.

These two water quality degradation problems can cause serious algae blooms, may be harmful to fish and can, if too concentrated, make Delta water unsuitable for agricultural and domestic drinking water uses.

B. MANDEVILLE ISLAND

1. General Description

Mandeville Island, which consists of 5,700 acres of primarily agricultural land, was reclaimed in 1918 and has been in agricultural production since 1920. The island has been owned and farmed by the Zuckermann family since 1920, Alfred Zuckermann being the current owner. In the past, the island's production was primarily asparagus and potato crops. Currently, small grain crops dominate production.

Mandeville Island has approximately 14 miles of levees which are maintained by Reclamation District 2027 at an annual cost of $40,000-$50,000.

2. Geology and Soils

The island's geology and soils are typical of the Delta. The Delta has experienced considerable geologic subsidence or downwarping since the latter part of the Cretaceous period, 70 million years ago. Before the more recent uplift and emergence of the coast ranges, the Delta and most of the Central Valley area were submerged beneath the sea. The development of the coast ranges and subsequent Central Valley sedimentation forced out the sea by depositing a thick layer of alluvium.

On Mandeville Island the Quaternary age alluvial deposits are overlain by three soil types. The most extensive of these is Venice peaty muck,[1] an acidic, organic muck. It has a partly decomposed surface layer. Fragments of tules (bulrushes) are visible throughout. Beneath the surface soil, the subsoil is a true peat which rests upon the fine-grained alluvial substrata. Staten peaty muck covers roughly 10% of the island surface. This peat soil is much like the Venice peaty muck, although it is distinguished by being more completely decomposed. It is also characterized by the presence of more soluble salts and a more neutral pH, or acidity. The Ryde soil covers somewhat less area than the Staten peaty muck. This is a partly organic and partly mineral soil which has formed through deposition of alternating layers of silt and peat. The Ryde soil was formed because of its proximity to the river. The slough channels in which it is found received more river silt than the interior soils of the island during natural (prereclamation) flooding. All three of these soils are highly productive and have a high water-holding capacity. The soil at the compost placement site is Venice peaty muck.

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[1] U.S. Department of Agriculture, Soil Survey of the Sacramento-San Joaquin Delta Area, California, 1941, p. 18.

3. Seismicity

Although the Delta area has been seismically active in the geologic past, it has been relatively quiet in the period of record. A compilation of earthquakes of magnitude 4.0 in California occurring between 1934 and 1961 published by the State Department of Water Resources shows the nearest earthquake epicenter to be 25 miles from the test site. Two known faults lie closer than that at a distance of 20 miles; however, these have remained relatively inactive. Epicenters located within 30 miles were as follows:[1]

Peters	September 1940	4.0
Livermore	April 1943	4.0
Livermore	April 1943	4.1
East of Livermore	May 1946	4.6
Concord	October 1955	5.4
Concord	May 1958	4.1

It is important to note that in the 1906 earthquake centered at Olema (magnitude 8.3), none of the levees existing at that time failed, possibly due to the physical properties of the peat underlying the whole area. Apparently, the ability of peat to transmit or amplify destructive seismic shocks is very small.[2]

4. Visual Quality and Noise

Visual experiences on Mandeville Island are similar to those of other Delta islands, dominated by expanses of open cultivated fields and narrow sloughs and waterways. Limited natural vegetation, primarily patches of tule, exist along aquatic margins.

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[1] California Department of Water Resources, Crustal Strain and Fault Movement Investigation, Faults and Earthquake Centers in California, Bulletin No. 116-2. January 1964, p. 61.

[2] H. Bolton Seed, University of California, Berkeley, personal communication, October 1973.

The low relief of the area, with a few manmade structures and trees, allows the open view of the sky to become a major visual element. During clear weather, views of the Coast Range and Mt. Diablo to the west and the Sierras to the east are impressive.

The site has low ambient noise levels, with the majority of noise generated by infrequent use of agricultural equipment and powerboat use in adjacent waterways.

5. Vegetation

The natural freshwater marsh vegetation of Mandeville Island was replaced many years ago with the introduction of agricultural land uses to the area. In the undisturbed condition, these freshwater marshes consisted of such species as the bulrushes or tules (*Scirpus robustus*, *S. Olneyi*, *S. cernuus* var. *californicus*, and *S. acutus*), the common cattail, the narrow-leafed cattail, the spikerush (*Heleocharis* species) and several sedges.[1]

The agricultural conversion of Mandeville Island is almost totally complete--almost none of the original vegetation remains. Cultivated crops are planted up to the crest of the levee that serves as a roadway as well as a barrier to flooding. Nonagricultural vegetation is restricted to isolated and highly modified stands that occupy some drainage ditches and sections of the island's shoreline. Small stands of common tule occur along the edges of the San Joaquin waterway, while patches of introduced annual grasses and weeds grow in some areas of the island. No marshland or riparian growth occurs at the proposed levee reinforcement site. Crops normally raised at the site include oats, milo and corn.

6. Wildlife

With the elimination and modification of marshland habitat, there have been accompanying changes in the wildlife of the area. Totally aquatic species have been eliminated from the island ecosystem and have largely been replaced by visiting terrestrial or dryland species that are

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[1] H. L. Mason, *A Flora of the Marshes of California* (University of California Press, Berkeley, 1957), p. 878.

capable of coexisting with the agricultural activities. Pintail, shoveler, American widgeon, green-winged teal and ring-necked duck are the most important migratory species. Marshes and waterways provide habitat for several species of resident ducks including the mallard, cinnamon teal, wood duck, redhead, canvasback and ruddy duck. The Canada, white-fronted and snowgoose are the most common geese of the Delta area. Although geese use marshy areas for refuge, they regularly visit the cultivated fields primarily in search of grains and grasses for food during their winter residence.

Agricultural activities generally limit the value of Mandeville Island to most other wildlife. Only those species capable of exploiting the artificial food supplies and limited cover are of any significance. These include highly mobile ground-feeding passerine birds and the more adaptable small mammals, represented respectively by blackbirds, cowbirds, herons, crows, goldfinches, sparrows and the Audubon cottontail, pocket gopher, raccoon and skunks. The introduced pheasant is a major gamebird species on the island, although hunting by the public is prohibited.

The waterways provide highly productive fish habitat and are major routes in the migration of anadromous fish such as the king salmon, steelhead trout, striped bass, white sturgeon and American shad.[1] All these species use the waterways adjacent to Mandeville Island, although use by shad and sturgeon of the immediate vicinity is very limited. Although spawning activities are extremely limited, the middle and lower reaches of the San Joaquin River and adjacent sloughs are important nursery grounds, particularly for the striped bass. Juvenile striped bass use the shoal areas during a significant part of their maturation when they consume large quantities of the Mysid shrimp (Neomysis awatschensis). Local forage fishes are important food items in diet of older striped bass.

Sacramento smelt use local portions of the San Joaquin River principally during the winter and spring seasons,

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[1]California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fishes of the Delta, Fish Bulletin 136, 1966, p. 168.

while green and white sturgeon, starry flounder, brown bullhead, black bullhead, channel catfish, white catfish, black crappie, bluegill, warmouth, carp, Sacramento squawfish, golden shiner and several others are permanent residents.[1]

7. Climate and Air Quality

The climate and air quality of Mandeville Island is similar to the rest of the Delta. Climatological data for Mandeville Island is shown in Table 1. Mandeville Island has a modified marine climate, with generally light and seasonal rainfall. Temperatures are mild but have a greater range than areas closer to the ocean. Summer winds are almost exclusively from the West. In winter, winds are more variable and generally lighter.

Air quality data for Stockton and Pittsburg are given in Tables 2 and 3. Pittsburg is located at the west end of the Delta and Stockton is located at the east end. Both stations record frequent occurrences of oxidant smog which exceed the federal standard, while carbon monoxide and nitrogen dioxide concentrations seldom exceed the standards.

Suspended particulate matter is also an air quality problem in the Mandeville Island area. Table 4 shows that high concentrations of particulate matter are much more frequent at Stockton than other areas in the San Francisco Bay region. This is due partly to Stockton's position downwind of the Delta where peat dust is eroded away by the wind. This erosion is greatest during the summer when the soil is dry and winds are high. Generally, winds greater than 15 miles per hour are required to lift peat soil particles into the air. Winds of this strength occur approximately 9% of the time at Stockton, the nearest U.S. Weather Bureau station.

8. Land Use

Most of the island's interior is used for agricultural crops, as mentioned. Production figures for 1972 were:

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[1]California Department of Fish and Game, Ecological Studies, p. 168.

TABLE 1

CLIMATOLOGICAL DATA FOR MANDEVILLE ISLAND

Rainfall[1] and Temperature[2]

	Rainfall (Inches)	Mean Max. Temp. (°F)	Mean Min. Temp. (°F)	Mean Temp. (°F)
January	2.75"	53.8°	37.1°	44.7°
February	2.94	59.4	38.7	48.8
March	1.31	65.3	39.7	52.8
April	1.25	72.5	43.9	58.1
May	0.60	78.8	47.8	63.4
June	0.04	86.0	51.9	68.8
July	0.00	92.0	54.1	72.7
August	0.00	89.9	52.3	70.9
September	0.39	87.1	50.4	68.6
October	0.44	78.2	45.0	61.2
November	0.77	65.0	38.6	51.6
December	1.84	55.4	36.7	45.8

Wind Direction[3] (% of time)

N	4.9%	E	3.0%	S	2.2%	W	19.0%
NNE	1.4	ESE	3.1	SSW	1.0	WNW	13.2
NE	2.0	SE	6.6	SW	3.4	NW	15.5
ENE	0.9	SSE	3.0	WSW	6.5	NNW	5.0

Windspeed (% of time)

0-3 MPH	4-10 MPH	11-20 MPH	21-30 MPH	Over 30
20%	43%	33%	3%	1%

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[1] U.S. Department of Commerce, Climatography of the United States, No. 86.4, 1972.

[2] Pacific Gas & Electric Company, Mean Hourly Temperatures, 1967.

[3] California Department of Water Resources, Office Report on Wind in California, August 1960.

TABLE 2

OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT STOCKTON, 1972[1]

	Pollutant					
	Oxidant[2]		Carbon Monoxide[3]		Nitrogen Dioxide[4]	
	Hours	Days	Hours	Days	Hours	Days
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	5	2	9	2	0	0
April	0	0	0	0	0	0
May	1	1	0	0	0	0
June	1	1	0	0	0	0
July	0	0	0	0	0	0
August	22	7	0	0	0	0
September	19	8	0	0	0	0
October	1	1	16	2	0	0
November	0	0	0	0	0	0
December	0	0	0	0	0	0

[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

TABLE 3

OCCURRENCES OF POLLUTANT CONCENTRATIONS
EXCEEDING AIR QUALITY STANDARDS AT PITTSBURG, 1972[1]

	Pollutant					
	Oxidant[2]		Carbon Monoxide[3]		Nitrogen Dioxide[4]	
	Hours	Days	Hours	Days	Hours	Days
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	5	2	0	0	0	0
April	6	2	0	0	0	0
May	6	3	0	0	0	0
June	24	6	0	0	0	0
July	49	9	0	0	0	0
August	43	10	0	0	0	0
September	13	10	0	0	0	0
October	0	0	0	0	0	0
November	0	0	0	0	0	0
December	0	0	0	0	0	0

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

TABLE 4

SUMMARY OF MEASUREMENTS OF SUSPENDED PARTICULATES FOR SELECTED BAY AREA STATIONS, 1972*

Station	Total Number of Samples	260 mg**/m^3	150 mg/m^3***	100 mg****/m^3
San Francisco	125	0	0	2
Stockton	56	0	6	22
Pittsburg	130	0	0	3

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*California Air Resources Bureau, California Air Quality Data, February 1973.

**Federal primary standard (24-hour sample).

***Federal secondary standard (24-hour sample).

****California state standard (24-hour sample).

asparagus, 750 tons; grapes, 2,000 tons; and small grains (barley, corn, milo, oats, wheat, safflower), 9,000 tons. A limited amount of land is set aside for equipment storage and maintenance yards, roads, drainage ditches, residences, etc. The major island structures are located along the 14-mile levee road on the island's perimeter.

Recreational use is restricted on the island, but the adjacent waterways provide considerable recreation for fishermen and pleasure boaters. Extensive marina facilities are located along nearby Bethel Island, west of Mandeville Island.

9. Socioeconomic Setting

There are approximately 30 full-time workers on the island and 50 year-round residents, most of whom are Spanish-speaking. Many of the higher paid employees work on the island and live in Stockton. During harvest season, a maximum of 400 transient laborers work on the island. Resident children are bussed to Holt Elementary School near Holt or attend Tracy High School.

There is one residence near the levee test site and three labor camp structures and an unused schoolhouse about a mile away. Mandeville Island has a current market value of approximately $1,000 per acre.

10. Utilities

Electricity is supplied to the island by Pacific Gas and Electric, with telephone service provided by Pacific Telephone and Telegraph. Domestic water is from standard two-inch cased wells located on the island, while agricultural water is drawn from adjacent waterways.

11. Transportation

Access to the island is available by land or water. Land access is via State Highway 4 and Bacon Island and then along the levee to the Mandeville Island bridge. Traffic on Mandeville Island is currently restricted to the island owner, farm laborers and equipment and occasional sightseers. The levee road is occasionally closed to traffic during the winter due to deep mud. Boat access is avail-

able along the margins of the island except where levee maintenance operations have rip-rapped the shoreline, making boat landing hazardous.

12. Special Problems

a. Levee Instability

As the soil surface has subsided, the levees, built to protect the island from flooding, have lost the buttressing support of peat soils on the inside. In addition, dredged river sediments have been used to strengthen the levees. The added weight of these sediments has compressed the underlying peat foundations, causing levee settlement and cracking.

Mandeville Island last flooded in 1937 when a combination of wave erosion, river flooding and high tide caused a stretch of levee on the island's western side to fail. The levees are more precarious today than they were in 1937. If the soil loss is not stopped or reversed, the levee's stability and ability to protect the island will diminish even further.

b. Land Subsidence

Since its reclamation between 1916 and 1920, the surface of Mandeville Island has been lowered between 15 and 20 feet. At the test levee site the landward base of the levee is 11 feet below the high tide line and 15 feet below the crest of the levee, as shown in Figure 10.

c. Water Quality

In a complex integrated aquatic ecosystem like the Delta, any significant water quality problems would tend to be felt throughout the entire system rather than isolated to a particular area. Thus, the water quality of the waterways around Mandeville Island is best understood by discussing the problems confronting the entire Delta.

Large-scale human endeavors (i.e., hydraulic mining in the Sierra foothills), land reclamation and diversion of water have drastically altered the aquatic environment. The water quality has obviously been altered in relation to

these uses. However, the Delta waters still serve a multiplicity of uses.[1]

Present factors which diminish the water quality of the Delta are the diversion of flow from the Delta and possible saltwater intrusion, pollutants contained in irrigation drainage water from the islands, waste from recreational boats, municipal wastes and some industrial waste in the western area of the Delta. By far the most crucial problems are saltwater intrusion and irrigation drainage.

When saline water moves into the Delta, water quality diminishes, primarily because saline water is unsuitable for present uses such as domestic water supplies and irrigation. Saltwater intrusion into the Delta can occur for a variety of reasons, principally from a reduction inflow. It is estimated that the annual water supply to the Delta and upper Bay was originally 30 million acre-feet per year. In accordance with future water plans, this would be reduced from the present 18 million acre-feet per year to 7 million acre-feet per year by the year 2020, with a minimum of 1,300,000 acre-feet per year in a critical year.[2] Other factors, such as the 1972 Andrus Island levee break, also cause saline intrusion. As a result of this break, there was a substantial intrusion of saline waters into the western, central and eventually southern portions of the Delta. Under normal conditions, the intrusion can be discernible as far into the Delta as Mandeville Island.

Over 400,000 acres of Delta island land are under intensive cultivation. This reclaimed land is below the

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[1] California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, Bulletin No. 123, August 1967, pp. 3-8.

[2] Board of Supervisors, Contra Costa County, Statement of the Board of Supervisors of Contra Costa County, Ex-Officio Governing Board of the Contra Costa County Water Agency Regarding "The Andrus Island Levee Break," September 27 and 28, 1972, p. 13.

adjacent water levels, and drainage ditches and pumping stations are required to pump water back over the levees. This irrigation drainage water contains variable amounts of fertilizers, pesticides and mineral salts left in the soil by the evaporation of water during the growing season and leached out into the drainage system by rains and intentional flooding of the land in winter.[1]

Previous and ongoing water quality investigations have provided extensive background information on Delta waters.[2] Water quality monitoring has been carried out by the California Department of Water Resources and the U.S. Bureau of Reclamation. This information has been published in the "Delta and Suisun Bay Water Quality Investigation" (Department of Water Resources, 1967) and subsequent yearly progress reports.[3] The present monitoring program is required under the State Water Resources Control Board Decision 1379. The program is formulated after a 1970 study and is continually expanding as manpower and equipment become available.[4]

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[1] Frank Stead, Proposed Water Quality Monitoring for the Bay Delta Resource Recovery Demonstration Project, September 18, 1973, p. 1.

[2] California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, Bulletin No. 123, August 1967.

[3] Conversation with Jerry Cox, Chief, Delta Branch, Central District, California State Department of Water Resources.

[4] California State Water Resources Control Board, An Environmental Monitoring Program for the Sacramento-San Joaquin Delta and Suisun Bay, Publication No. 40, May 1970, and conversation with Cecil Morton, Environmental Specialist, California State Water Resources Control Board.

The Bureau of Reclamation maintains three surveillance stations near Mandeville Island and have data from these stations on a wide diversity of water quality characteristics; e.g., pesticides, heavy metals, nutrients and other chemical and physical factors. This data is retained within the STORET system (the national water quality information and retrieval system).

Intermittent studies of the irrigation and drainage waters have also been made. Irrigation water quality is highest during the winter due to greater waterflows through the Delta. Drainage water quality varies seasonally, being lowest in the winter when the mineral salts are leached out of the soils. Other observed characteristics of the drainage waters, in addition to containing high levels of pesticides (soil fumigants and insecticides), herbicides and fertilizers, are that they vary considerably in relation to the quality of the supply water and that they have a high BOD (biological oxygen demand).[1]

Although water quality problems exist in the Delta, the potential for further degradation also exists. Further diversion of inflow to the Delta and increased development and subsequent water reduction in the Central Valley could have far-reaching environmental effects not immediately discernible or limited only to the Delta area.[2]

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[1]California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, p. 120.

[2]California State Water Resources Control Board, An Environmental Monitoring Program for the Sacramento-San Joaquin Delta and Suisun Bay, p. 11.

C. BERKELEY

1. Land Use

The Berkeley City Planning Department is currently undertaking a survey to determine which sites would be most advantageous for the location of a transfer station. Although the proposed West Berkeley Industrial Park specifically restricts refuse processing facilities, the remainder of the area between Emeryville and Albany and between the Eastshore Freeway and San Pablo Avenue is zoned M (manufacturing) and should allow solid waste processing.

The existing landfill site at the north waterfront is the proposed location for the composting operation. According to the present Berkeley Master Plan, the area will eventually be used for parks and recreation. The site is owned by the city and is in an unclassified zone (no use permit can be granted without a change in zoning status). The city departments of Recreation and Parks, Public Works and Planning are cooperating in the final planning and development of this area, and shaping of the already filled land on the southern portion has begun. The site proposed for the composting operation is on the north or active portion of the landfill. The composting operation was defined by the City Council as an appropriate temporary land use.

2. Geology, Soils and Seismicity

The composting site would be located on previously filled land adjacent to San Francisco Bay at an elevation of about 12 feet (above mean sea level). The site is located over a large westward sloping alluvial fan which is composed of sediments eroded from the Berkeley Hills. These deposits were laid down in typical alluvial fan fashion by intermittent streams as they migrated back and forth across the fan surface. The terrain surrounding the site is nearly flat. Maximum local relief is 20 feet.

The site is composed of fill less than 25 years old. This fill is resting upon a sequence of geologically recent San Francisco Bay mud and other fine-grained sediments. The soil-like materials at the surface are the product of landfilling operations carried out since 1964. Although

these materials are capable of supporting plant life, no true soil profile exists.

The Berkeley composting site is in a seismically active area, as is most of the California coastal region. The San Andreas fault zone lies 17 miles to the southwest, and the Berkeley-Hayward and Calaveras fault systems lie 1.7 miles and 11 miles to the northeast, respectively. No known faults pass directly through the site.

According to California Department of Water Resources literature, between 1934 and 1961 twelve earthquakes of Richter magnitude 4.0 or greater were recorded having epicenters within 20 miles of the site, as follows:

Place Name	Month-Year	Magnitude
Montclair	March 1937	4.5
San Leandro	December 1942	4.3
East Oakland	October 1952	4.2
Albany	October 1952	4.0
San Leandro	December 1954	4.5
Concord	October 1955	5.4
South San Francisco	March 1957	4.4
Daly City	March 1957	4.0
Daly City	March 1957	5.3
Gulf of Farallones	March 1957	4.2
Concord	May 1958	4.1
Gulf of Farallones	December 1958	4.7

In addition to the magnitude 8.3 earthquake in 1906 centered at Olema, four major earthquakes were observed nearby on these fault systems in the nineteenth century. Two were estimated at magnitude 7 on the Berkeley-Hayward fault, one at magnitude 7 on the San Andreas,[1] and another of unestimated magnitude on the Calaveras.

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[1] California Division of Mines and Geology, Crustal Movement Investigations in California: Their history, data and significance, Special Publication 37, 1972, p. 2.

3. Vegetation and Wildlife

Vegetation in the proposed Berkeley composting site reflects the disturbed nature of the area. Past and present refuse disposal activities are continually resulting in the dumping, leveling and subsequent disruption of onsite vegetation. Therefore, the vegetation is maintained at a disturbed and early successional condition, preventing the establishment of woody species. The majority of plant species present consists of species capable of tolerating a regime of continual disturbance, mainly annual grass and herbs of exotic origin. Mustards, mallows, yarrow, dandelion, plantain, thistles and grasses of the bromegrass, ryegrass, oats and fescue genera represent the most common plants.

Wildlife is equally restricted by the land dumping and leveling and appears to be limited largely to exotic introductions such as the Norway rat and the black rat, and other opportunistic scavengers such as the resident western gull, the wintering herring gull and California gull. Less commonly observed gulls are the ring-billed gull and the glaucus-winged gull. Populations of the deermouse and the meadow mouse may be established temporarily but are sooner or later eliminated by refuse dumping. The only other mammals of significance that may occasionally occupy the area include the raccoon, black-tailed jackrabbit and the house mouse.

No amphibians would be expected to occur at this site. The area is of marginal value to a few reptiles, possibly including the western fence lizard, alligator lizard, ringneck snake and the common garter snake. No snakes or lizards were observed during field investigations.

Adjacent open water areas are used by pelicans, cormorants, loons, scaup and other diving ducks and by mergansers and coot for feeding and resting purposes. A wide variety of shorebirds feed and rest on tidal flats, a mile from the composting site on the southeast portion of the peninsula.

4. Climate and Air Quality

The climate of Berkeley is greatly influenced by marine air which flows through the Golden Gate. Cool air is drawn through the Golden Gate by the pressure differential set up by the large temperature difference existing between the ocean and the Central Valley.

Berkeley has a marine climate and has weather characteristic of California coastal regions. Rain occurs mainly in the winter months, while summers are cool and dry. Temperatures are mild, with September being the warmest month (Table 5).

Winds are generally westerly, reflecting Berkeley's position with respect to the Golden Gate gap. The presence of the East Bay hills causes a split in westerly flow through the Golden Gate, and this divergent windfield causes diminished winds over the Berkeley area.

Air quality is monitored near the Berkeley area at Richmond, approximately six miles northeast of the project site. A summary of air quality data is given in Table 6.

Air quality in the Berkeley area varies greatly with weather conditions. In general, Berkeley is well ventilated. However, under calm conditions when an elevated inversion is present, photochemical oxidant smog is produced and trapped against the East Bay hills, causing significant values of photochemical oxidant over Berkeley. In addition, carbon monoxide concentrations can reach high levels under calm air conditions and surface inversion conditions, which occur mainly in fall and winter months.

5. Visual Quality and Noise

The Berkeley composting site is on a typical San Francisco Bay landfill. Due to current filling operations, large mounds of earth, concrete and dredging spoils dominate the site. The continual disturbance allows growth of only sparse vegetation. Thus, the site in its present state is not visually attractive.

TABLE 5

CLIMATOLOGICAL DATA FOR BERKELEY

Rainfall and Temperature[1]

	Rainfall (Inches)	Mean Max. Temp. (°F)	Mean Min. Temp. (°F)	Mean Temp. (°F)
January	4.68"	55.3°	42.2°	49.4°
February	3.91	58.5	44.6	51.9
March	3.19	61.1	45.8	54.0
April	1.68	63.9	47.7	55.9
May	0.81	66.0	49.9	58.3
June	0.18	69.4	52.4	61.0
July	0.01	69.5	53.7	61.5
August	0.04	69.1	54.1	61.6
September	0.22	71.2	54.5	63.4
October	1.17	69.2	52.3	61.3
November	2.19	63.3	47.9	56.2
December	4.30	56.7	43.6	51.2

Wind Direction[2] (% of time)

N	4.6%	E	2.2%	S	4.4%	W	22.1%
NNE	1.0	ESE	3.1	SSW	3.1	WNW	9.3
NE	1.1	SE	5.2	SW	8.0	NW	8.0
ENE	0.6	SSE	2.7	WSW	9.2	NNW	4.8

Windspeed (% of time)

0-3 MPH	4-10 MPH	11-20 MPH	21-30 MPH	Over 30
16%	45%	33%	5%	1.6%

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[1] U.S. Department of Commerce, Climatography of the United States, No. 86-4, 1972.

[2] California Department of Water Resources, "Office Report on Wind in California," August 1960 (data for Alameda Naval Air Station).

TABLE 6

OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT RICHMOND, 1972[1]

	Pollutant					
	Oxidant[2]		Carbon Monoxide[3]		Nitrogen Dioxide[4]	
	Hours	Days	Hours	Days	Hours	Days
January	0	0	0	0	0	0
February	1	1	9	2	0	0
March	3	3	-	-	0	0
April	5	2	-	-	0	0
May	0	0	-	-	0	0
June	4	1	-	-	0	0
July	3	2	-	-	0	0
August	0	0	-	-	0	0
September	7	3	-	-	0	0
October	0	0	-	-	0	0
November	0	0	-	-	0	0
December	0	0	-	-	0	0

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

Impressive views are obtained from the site, however, including the Berkeley and Richmond hills to the east and north, and San Francisco, the Golden Gate Bridge and the Marin hills to the west. Southern views are partially blocked by the hotel complex located directly to the south of the site. Most of the noise on the site is from the wind, the nearby freeway and onsite fill vehicles.

6. Utilities

Water for Berkeley is supplied by the East Bay Municipal Utility District (EBMUD). The only source of water for the composting site is a 12-inch watermain located 1,200 feet southwest of the site, at the end of Spinnaker Road.

Electrical power is supplied to Berkeley by Pacific Gas and Electric Company. The nearest power line to the proposed composting site is located about 200 feet southeast of the site. The line is underground and surfaces adjacent to the Berkeley landfill site office.

7. Socioeconomic Setting

Both proposed sites for the Demonstration in Berkeley are located in Census Tract 4220, which extends from the Albany boundary on the north to the Emeryville border on the south along the Bayshore Freeway. Within the census tract, industrial development clusters near the Bayshore and residential development near San Pablo Avenue. Of a total labor force of 532 residents, 13.7% were unemployed in 1970. The 1970 census indicates a large black minority in the tract (29.5%), with a median income ($7,382) well below that for the city ($9,987). A statistical outline of the tract and Berkeley west of San Pablo Avenue is presented in Table 7.

Berkeley is the fourth largest municipality in the San Francisco-Oakland Statistical Municipal Study Area with a 1970 population of 116,716. The city has a black minority (23.5%). Of a total labor force of 30,780 in 1970, there was an 8.5% unemployment rate in the civilian labor force.

TABLE 7

BERKELEY NEIGHBORHOOD AND CITY-WIDE CHARACTERISTICS

	Census Tract 4220	Berkeley West of San Pablo 4220, 21, 32	Berkeley
Total population	2,425	8,330	116,716
Black population	29.5%	56.1%	23.5%
Spanish-speaking population	12.7%	12.6%	4.2%
Total households	579	2,034	24,703
Persons per household	3.01	2.87	2.32
Median school years	13.5	12.6*	12.9
Employed in professional or managerial positions	37.7%	20.0%	43.0%
Median family income	$7,382	$7,727*	$9,987
Families with income below poverty	12.5%	16.6%	10.6%
Total housing units	722	2,971	47,365
Average number of persons per unit	3.14	2.80	2.61
Same housing unit since 1965	51.7%	55.1%	38.0%
Units owner-occupied	125	668	14,036
Units renter-occupied	585	758	26,671
Median value homes	$15,400	$16,400*	$26,600
Median contract rent	$72	$94*	$128
Total labor force	532	1,886	30,780
Unemployed civilian labor force	13.7%	11.6%	8.5%

*These figures are calculated as weighted average median; i.e., % population in each census tract as total of West Berkeley x median for that census tract.

Sources: U. S. Department of Commerce, 1970 Census of Population and Housing, SMSA, San Francisco-Oakland, California, PHC (1) - 189, April 1972, and Planning Department, Berkeley Facts, 1971.

TABLE 8

LABOR FORCE CHARACTERISTICS OF BERKELEY POPULATION BY INDUSTRY

	1960[1]	1970[2]
Mining	52	-[3]
Construction	1,540	1,374
Manufacturing	6,367	4,895
Transportation, communications and utilities	2,594	2,699
Wholesale trade	1,162	1,011
Retail trade	4,925	5,574
Business, repair and personal services	3,418	4,473
Private households	1,836	-
Hospitals and education	10,913	17,014
Professions and public administration	7,694	9,491
Finance, insurance and real estate	-[3]	2,748
Other	6,462	1,283
Total	46,963	50,562

[1]Berkeley Planning Department, Berkeley Facts, 1971 Employment Statistics, p. 20.

[2]U.S. Department of Commerce, Bureau of Census, "Labor Characteristics Table," 1970, p. 3.

[3]Included in "Other" category.

As shown in Table 8, total employment in Berkeley in 1960 was 46,963.[1] Employment in manufacturing was 6,367 and in wholesale trade, 1,162.[2] In 1970 the total employment increased to 50,562, while manufacturing and wholesale trade employment declined to 4,895 and 1,011, respectively.[3] All other industries, except construction employment, increased in 1970.

8. Existing Solid Waste Operations

Berkeley's Department of Services is responsible for the collection and disposal of municipal solid wastes. An average of approximately 150 tons per day is collected and deposited at the Berkeley landfill site. The Class II landfill site (no hazardous wastes are accepted) is owned by the City of Berkeley and leased to the Berkeley Landfill Company. Only one-third of all solid wastes deposited onsite are collected by the Department of Services. The remaining two-thirds is brought by private collectors and individuals, many from outside the Berkeley area. The total site area of 40 acres is projected to be filled in four-five years.

Recycling stations receive cans and bottles at several locations throughout the city and monthly curbside collection of newspapers recently began. A recent survey indicated that 37% of all Berkeley's newspapers are being collected for recycling. As a result of education and recycling programs, Berkeley refuse collected by city vehicles declined by as much as 8,858 tons between 1969 and 1973.

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[1] Berkeley Planning Department, Berkeley Facts, 1971, p. 20.

[2] Ibid.

[3] U.S. Department of Commerce, Bureau of Census, "Labor Force Characteristics Table," 1970, p. 3.

9. Traffic

Currently refuse collection requires 46 packer truck trips per day, Monday through Friday, and 6 trips on Saturday to deliver refuse to the landfill site. The trucks travel on University and Gilman streets to cross the freeway to the landfill site, a distance of about four miles from the center of Berkeley. On weekends, approximately 600 vehicles, including private automobiles and commercial trucks, deliver refuse to the landfill site.

D. SIERRA POINT

1. Location, Land Use and Zoning

The proposed Sierra Point composting site is on an unused 25-acre parcel of land owned by the Sanitary Fill Company. The land is zoned M2, manufacturing, where heavy industry is permitted on a minimum of one-acre parcels.

A deepwater channel borders the site on the south and would provide barging access. Neighboring operations include the American Bridge Division of U.S. Steel and Healy-Tibbitts Construction Company which use the channel for barging.

The City of South San Francisco owns the marina to the southeast of the site and is anticipating expansion of its facilities.

2. Geology, Soils and Seismicity

The site is composed of fill less than seven years old. This fill is resting on a sequence of geologically recent San Francisco Bay mud and other fine-grained sediments.

The soil-like materials at the surface of the Sierra Point site are the product of land filling operations between 1966 and 1970.[1] Although these materials are capable of supporting plant life, no true soil profile exists. Profiles develop over time in response to precipitation and

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[1] Mr. Wayne Trewhitt, personal communication, November 1973.

the action of soil organisms. The end result is a layered lithic material in which particular chemical constituents are concentrated at each of several levels.

The site is in a seismically active area, as is most of the California coastal region. The San Andreas fault zone lies five miles to the southwest, and the Berkeley-Hayward and Calaveras fault systems lie 15 miles and 23 miles to the northeast, respectively. Splinter faults, or parallel offshoots from the San Andreas, pass within two miles of the site on the southeast and northwest sides. No known faults pass directly through the site.

According to California Department of Water Resources literature, between 1934 and 1961 eleven earthquakes of Richter magnitude 4.0 or greater were recorded having epicenters within 20 miles of the site, as follows:[1]

Place Name	Month-Year	Magnitude
Montclair	March 1937	4.5
Half Moon Bay	October 1942	4.3
San Leandro	December 1942	4.3
East Oakland	October 1952	4.2
Albany	October 1952	4.0
San Leandro	December 1954	4.5
South San Francisco	March 1957	4.4
Daly City	March 1957	4.0
Daly City	March 1957	5.3
Gulf of Farallones	March 1957	4.2
Gulf of Farallones	December 1958	4.7

3. Vegetation and Wildlife

The vegetation is typically that of a highly disturbed site and is largely composed of species characteristic of the early stages of secondary succession. Large expanses of bare or almost bare ground are interspersed with isolated pockets of low-growing vegetation. Plant colonization is

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[1] California Department of Water Resources, Crustal Strain and Fault Movement Investigation, Faults and Earthquake Centers in California, Bulletin No. 116-2, January 1964, p. 61.

TABLE 9

CLIMATOLOGICAL DATA FOR SOUTH SAN FRANCISCO

Rainfall and Temperature[1]

	Rainfall (Inches)	Mean Max. Temp. (°F)	Mean Min. Temp. (°F)	Mean Temp. (°F)
January	4.01"	55.8°	40.5°	48.6°
February	3.48	58.7	42.6	50.9
March	2.69	61.3	44.5	53.3
April	1.30	63.0	46.2	55.7
May	0.48	65.5	48.9	58.3
June	0.11	68.9	51.3	61.3
July	0.01	70.0	52.4	62.7
August	0.02	70.2	52.5	62.8
September	0.19	72.5	52.4	63.9
October	0.74	69.8	49.7	60.5
November	1.57	64.0	44.5	54.8
December	4.09	57.3	42.0	50.1

Wind Direction[2] (% of time)

N	1.3%	E	2.9%	S	3.3	W	18.7
NNE	1.2	ESE	2.6	SSW	2.9	WNW	21.5
NE	2.8	SE	4.3	SW	4.8	NW	14.2
ENE	2.5	SSE	2.6	WSW	5.4	NNW	1.6

Windspeed (% of time)

0-3 MPH	4-10 MPH	11-20 MPH	21-30 MPH	Over 30
16%	28%	38%	16%	2%

[1] U.S. Department of Commerce, Climatography of the United States, No. 86-4, 1972.

[2] California Department of Water Resources, Office Report on Wind in California, August 1960.

Airport, due to divergence as the airstream flows around the mountain. Winds during the summer are generally strong and westerly; during the winter both wind speed and direction are more variable.

Air quality at Sierra Point is generally good compared to the remainder of the Bay Area, since the moderate wind speeds result in considerable dilution of pollutants horizontally. The marine inversion, however, is quite persistent in the area, and high pollutant levels can be realized whenever the wind is light.

Air quality data for two neighboring air quality monitoring stations, San Francisco and Burlingame, are given in Tables 10 and 11. The San Francisco air quality monitoring station is located approximately eight miles northwest of the project site, in downtown San Francisco. Burlingame is a residential area located approximately seven miles southeast of the project site. These tables indicate that pollutant concentrations at these stations seldom exceed the existing standards. Significant concentrations of photochemical oxidant occur mainly during the summer, under conditions of bright sun and a strong marine inversion. Carbon monoxide, however, occasionally reaches high concentrations in the winter, when surface-based inversions trap auto emissions near the ground. Nitrogen dioxide is rarely a problem at either monitoring station.

5. Visual Quality and Noise

The Sierra Point site has very little diversification. Low, sparse vegetation and the absence of man-made structures contribute to the barren atmosphere.

Because the site was recently filled, it is not a natural area and thus has little scenic value. Offsite views include those of an active landfill site to the north, an industrial park and shipping channel to the south, San Francisco Bay to the east and the Bayshore Freeway and San Bruno Mountain to the west.

Noise is created primarily by the freeway near the site. Odors can be detected from gases escaping from the underlying fill, particularly after rains.

TABLE 10

OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT SAN FRANCISCO, 1972[1]

	Pollutant					
	Oxidant[2]		Carbon Monoxide[3]		Nitrogen Dioxide[4]	
	Hours	Days	Hours	Days	Hours	Days
January	0	0	21	2	0	0
February	0	0	0	0	0	0
March	0	0	35	4	0	0
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	0	0	0	0	0
July	0	0	0	0	3	2
August	0	0	0	0	0	0
September	0	0	0	0	0	0
October	0	0	12	2	0	0
November	0	0	8	2	0	0
December	0	0	8	2	0	0

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[1] California Air Resources Board, California Air Quality Data, February 1972.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

TABLE 11

OCCURRENCES OF POLLUTANT CONCENTRATIONS
EXCEEDING AIR QUALITY STANDARDS AT BURLINGAME, 1972[1]

	Pollutant					
	Oxidant[2]		Carbon Monoxide[3]		Nitrogen Dioxide[4]	
	Hours	Days	Hours	Days	Hours	Days
January	0	0	11	2	0	0
February	0	0	0	0	0	0
March	-	-	-	-	0	0
April	2	1	0	0	0	0
May	10	3	0	0	0	0
June	3	2	0	0	0	0
July	10	3	0	0	0	0
August	0	0	0	0	0	0
September	0	0	0	0	0	0
October	9	2	0	0	0	0
November	0	0	0	0	0	0
December	0	0	12	1	0	0

[1]California Air Resources Board, California Air Quality Data, February 1973.

[2]Federal standard for oxidant is 0.08 PPM (one-hour average).

[3]Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4]California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

6. Utilities

At present there are no utility lines for electricity, gas, water or telephone near the compost site.

7. Socioeconomic Setting

Sierra Point is included in Census Tract 6023, the northeastern section of South San Francisco, nearest the Bay. It has mixed industrial and residential land uses. In 1970, of the 3,169 residents in the tract, 20.7% were Spanish-speaking. There were a total of [illegible] persons employed here in 1970, 24.2% in manufacturing, 14.5% in retail trade and 13.1% in the government.

In 1970, 46,646 persons resided in South San Francisco, 16.4% of whom were Spanish-speaking. Total employment in the city was 19,496. Of this total, 20.9% worked in manufacturing, 16.9% in retail trade and 13.9% were government employees. A more detailed statistical description of the city and Census Tract 6023 is presented in Table 12.

8. Existing Solid Waste Operations

Municipal solid wastes in San Francisco are collected by the Sunset Scavenger and Golden Gate Disposal companies. The refuse is then taken to the transfer station which is owned and operated by SWETS (Solid Wastes Engineering Transfer Systems), located on Tunnel Avenue in San Francisco. The station receives 2,000 tons per day of refuse and has an ultimate capacity of 5,000 tons per day.

The residential portion of the wastes are processed through a hammer mill and a magnetic separator to recover ferrous metals. The remainder of the wastes are then loaded into transfer vehicles and taken 35 miles to the Mountain View Sanitary Landfill.

Bundled newspapers are collected by normal route trucks and unloaded at the transfer station for sale to a newsprint broker.

TABLE 12

SOUTH SAN FRANCISCO
NEIGHBORHOOD AND CITY-WIDE CHARACTERISTICS

	Census Tract 6023	South San Francisco
Total population	3,169	46,646
Black population	0.1%	1.3%
Spanish-speaking population	20.7%	16.4%
Total families	761	11,992
Persons per household	3.46	3.31
Median school years	12.3	12.3
Employed in professional or managerial positions	4.7%	7.1%
Median family income	$11,557	$12,281
Families with income below poverty	5.9%	4.1%
Total housing units	912	14,283
Average number of persons per unit	3.2	3.1
Same housing unit since 1965	53.4%	58.7%
Units owner-occupied	524	8,842
Units renter-occupied	323	4,615
Median value homes	$22,500	$26,100
Median contract rent	$128	$141
Total labor force	867	12,864
Unemployed civilian labor force	8.1%	3.9%

Source: U.S. Department of Commerce, 1970 Census of Population and Housing, SMSA, San Francisco-Oakland, California, PHC (1)-189, April 1972.

9. Traffic

Route trucks deliver San Francisco refuse to the transfer station. From the transfer station 85 transfer trucks travel daily along Highway 101 (Bayshore Freeway) to the Mountain View landfill site, a distance of 35 miles each way. Vehicular traffic along the access road to Sierra Point is limited to a small number of trucks delivering clean fill to the area of Sierra Point located in Brisbane.

V. ENVIRONMENTAL IMPACTS

A. GEOLOGY, SOILS AND SEISMICITY

Principal geologic and soils impacts of the Demonstration upon the island test site are expected to include:

1. Horizontal reinforcement of the adjacent levee segment and concomitant reversal of the present chronic loss of organic soil to oxidation.

2. Probable transverse and longitudinal cracking or fissuring of levee surfaces.

3. Increases in the potential for undetected seepage and sand boils along the landward levee surface.

4. Concentration of nonoxidizing residue (principally plastic film) at the soil surface after several years of project operation.

5. Development of a new agricultural soil.

The principal beneficial geologic and soils impact of the project would be to provide reinforcement for part of the Mandeville Island levee system. (The problem of deteriorating levee stability is described in the section on Levee Instability.) Compost material gradually would be built into a buttressing wedge which would help to offset the horizontal pressure exerted by the river. Associated with the establishment of this wedge would be a shift in the equilibrium that exists between formation of organic soil materials and their oxidation. The clearing of native vegetation to permit farming has virtually stopped the production of peat while increasing its loss by oxidation. Compost placement would begin rebuilding soils lost through oxidation. Its application would be much like reestablishing the production of peat at an accelerated rate, and would raise the land surface at the same time.

The most important adverse soils effect of compost placement as currently proposed would be probable cracking, or fissuring, of levee surfaces. According to Duncan and Seed,[1] the placement of a thick layer of compacted compost on the landward side of a Delta levee would cause large nonuniform settlements which would probably lead to the development of cracks in the levees. This is especially true along the top and sloping inner surfaces of levees. The fissuring has been estimated to amount to as much as three feet of total separation where a 500-foot wide wedge reaching a depth of 20 feet is laid down. These tensional fissures could run across the levee at the ends of the compost berm as well as running parallel to the levee axis.

The third principal effect of compost placement is the covering of the levee slope making difficult direct detection of seepage. When water from such seepage becomes cloudy from soil particles being washed out, it is a sign of possible incipient levee failure.

Duncan and Seed point out, however, that if compost placement is done slowly (by thin layering), subdrains are installed, and if levee surfaces are carefully monitored for signs of fissuring, the chances of levee failure would be diminished but not eliminated.[2] Although the difficulty of monitoring water seepage from the levee and from the natural ground is an important problem, all possible steps would be taken to insure that the subdrain design would accommodate the seepage. At the same time, piezometers would be installed so that water pressures could be monitored to be sure that dangerous water pressures would not build up beneath the berm.

The fourth principal effect is the accumulation or concentration of slow-to-decompose material (mainly plastic

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[1]J. M. Duncan and H. Bolton Seed, A Study of the Feasibility of Stabilizing Delta Levees with a Berm of Composted Municipal Waste, (see Volume III, Figure 12).

[2]Ibid., p. 15.

film) at the soil surface. This concern is primarily aesthetic, although it could also reduce the agricultural viability of the soil surface. While this problem is worth mentioning, it is not expected to be serious for several reasons. First, although residential use of plastics has been increasing during the past decade, much of it can be screened out of composted material without technical difficulty. Second, the rate of application of compost would be much greater than the rate of oxidation at the surface so that plastics would not concentrate rapidly, at least during the period of the Demonstration. And finally, plastic film is similar in buoyancy to other light compost constituents and may be removed by the action of the wind. This could cause a littering problem, however.

One of the important objectives of the Demonstration is to determine the viability of compost as a soil-like material. Compost is usually used as a soil amendment, being mixed into an existing soil at a particular number of tons per acre. This is done to improve its aeration and water-retention capacity and to add nutrients. The concept of the Demonstration is to place compost on top of the existing peat to serve as a soil by itself. Fresh compost, like virgin peat, is high in organic materials but lacks enough minerals to be a fertile soil. The compost must then be considered a parent soil material. As the organic portion of the compost decomposes, a mineral ash residue builds up, eventually reaching a fertile balance. The rate at which the fertility of the compost will develop is to be monitored during the Demonstration.

The seismic impacts of the Demonstration at the test site and Mandeville Island as a whole revolve around the question of levee stability during a major earthquake. No Delta islands were as far below sea level at the turn of the century as Mandeville Island is today. However, the fact that no levees failed during the infamous 8.3 magnitude earthquake of April 1906 has led H. B. Seed to the conclusion that the Delta peat has a limited ability to transmit or amplify earthquake shaking to overlying structures such as levees.[1] Furthermore, the relative

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[1] H. Bolton Seed, Department of Engineering, University of California Berkeley, personal communication, October 1973.

seismic inactivity of the area, coupled with the absence of identifiable faults nearby, suggests that future seismic activity would not be great. In any event, there is no indication that the compost berm would affect the performance of the levee in an earthquake in any significant way.

At the Berkeley and Sierra Point composting sites, except for the covering of perhaps five acres of artificial fill soils, there will be no significant geologic hazards or soils impacts due to the Demonstration. Both involve facilities which cause minimal loading of the artificial fill soils. Soil liquefaction, or site failure under compressional shock, is the principal seismic hazard that exists at present at Berkeley and Sierra Point. This hazard would not be significantly altered by the construction and operation of the Demonstration.

B. VEGETATION AND WILDLIFE

In view of the disturbed nature of the Berkeley and Sierra Point composting sites, the impact of the proposed composting operations on wildlife and vegetation would be slight, provided measures are implemented to prevent the excessive leaching of liquid wastes into adjacent Bay waters, and safeguards are implemented to prevent the development of a rodent pest problem. A rodent-proof containing wall would eliminate this possibility.

The presence of rich organic sludge could attract additional populations of scavenging birds, particularly gulls, but the numbers involved would be negligible, especially in comparison to those attracted to the existing landfill operation in Berkeley.

At Mandeville Island, the direct impact of the levee reinforcement program on wildlife and vegetation at the test site is considered to be negligible because of the small area involved and because of present agricultural uses. However, since the program would introduce new environmental contaminants that could conceivably leach out into local ecosystems, the indirect effects of the project are likely to be more serious and far-reaching. Adverse effects to fish and wildlife are likely to develop if sufficient quantities of pollutants leach into the surrounding aquatic systems. Contamination of

the human food resources contained in fish and shellfish is also possible.

It is vital to appreciate the biological importance and fragility of freshwater and saline aquatic communities if the contamination aspect is to be placed in perspective. Estuaries support highly productive and complex biotic communities.[1] Marshes and estuaries are among the most productive biotic communities known, and the Sacramento-San Joaquin estuary is no exception.[2] As a natural system, estuaries are well known for their fragility and vulnerability to modification.[3] Estuaries serve as a nursery and feeding ground for a great variety of animals from crayfish, shellfish and crabs to fish and birds. Many fishes and birds depend on the estuary system during some or all stages of their life cycles. Estuaries are known to provide food for species that permanently reside outside the strict confines of the system, and therefore changes in the local system can induce effects in animal populations well downstream of the specific site of influence (for example, the marine ecosystem).

The likelihood of environmental contamination is impossible to predict on the basis of existing background data, and the answering of this question through an extensive monitoring program is one of the prime objectives of the Demonstration. Some of the more significant pollutants can be discussed in terms of their potential impact.

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[1]P. A. Douglas and R. H. Stroud, ed., A Symposium on the Biological Significance of Estuaries, Sport Fishing Institute, Washington, D.C., 1971.

[2]California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Protection Study Report No. 8, p. 94.

[3]B. H. Ketchum, The Water's Edge--Critical Problems of the Coastal Zone (Cambridge: Massachusetts Institute of Technology, 1972), p. 393.

The major contaminants involved are polychlorinated biphenyls (PCBs), phthalate acid esters (phthalates) and heavy metals. These pollutants are well known for their persistence and wide dispersion in the physical and biotic environment, their resistance to metabolic breakdown, their affinity to living tissue, their ability to accumulate in food chains, and their toxicity to living organisms.

<u>Polychlorinated Biphenyls</u>

PCBs are widely used in electrical and heat-transfer appliances, hydraulic fluids and lubricants, and household plastic articles where they are used as plasticizer agents. They are a major constituent of the polyethylene group of plastics, and until recently were widely used in food-wrapping films and containers.[1]

PCBs have been detected in sewage outfalls originating from industrial areas and soils adjacent to landfills and dumps.[2] PCBs apparently enter the environment during spills and losses during their manufacture, the vaporization and leaching from PCB-containing formulations and from the waste PCBs or PCB-containing liquids deposited in dumps or carried by sewage systems. The mode of transport within the environment is extremely complex, but PCBs are generally dispersed by adsorption on airborne or waterborne particulates. They are known to diffuse through the soil, or to be transported with eroding soil particles. Bottom sediments of lakes and rivers are known to accumulate considerable quantities of PCBs with time.

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[1] I. C. T. Nisbet and A. F. Sarofim, "Rates and Routes of Transport of PCBs in the Environment," <u>Perspective on PCBs</u>, <u>Environmental Health Perspectives</u>, Experimental Issue No. 1 DHEW Publication No. (NIH) 72-218, 1972.

[2] <u>Ibid</u>.

Eventually, however, significant quantities of this synthetic organic compound become accumulated in animal tissues. Although PCBs are relatively insoluble in water, they are extremely soluble in fat-rich animal tissue. Through the process of biological magnification, fish and birds high in the food chain accumulate high quantities of the contaminant. PCBs are considered to be ubiquitous components of the global environment and are found in the biotic and abiotic environment far from areas of original discharge and at far higher concentrations than the surrounding medium.[1] Aquatic invertebrates and fish can accumulate PCBs to levels of 3,000 and 70,000 times higher than those in the ambient water. Significant levels have been found in marine birds that rarely approach land except to breed on isolated islands. Fish are able to concentrate PCBs to an order more than 40,000 times that of exposure levels.

PCBs have several sublethal effects on various parameters of the reproductive mechanisms of animals. Toxicity varies greatly depending on many factors such as the species, its physiological condition, mode of reproduction, diet, local environment, etc. Aquatic invertebrate reproduction can be adversely affected at concentrations of 5 mg/l or less.[2]

PCBs will be introduced to compost from urban refuse and sewage sludge. Recent analysis of a number of liquid sewage outfalls along the coast of California indicates that PCB escapement varies considerably, depending upon

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[1] R. W. Risebrough and B. de Lappe, "Accumulation of Polychlorinated Biphenyls in Ecosystems," <u>Environmental Health Perspectives</u>, Volume 1, 1972, pp. 39-46.

[2] D. Stalling and F. L. Mayer, "Toxicities of PCBs to Fish and Environmental Residues," <u>Environmental Health Perspectives</u>, No. 1, 1972, pp. 159-164.

the original source of the treated sewage.[1] Sewage districts that encompass both urban residential and industrial areas release the largest amounts of PCBs. Thus, the East Bay Municipal Utility District's outlet was found to release two kilograms daily in the liquid component. At one San Francisco industrial outlet near the Bay Bridge, 0.6 kilograms daily were being released. The higher value of the EBMUD outlet reflects the fact that sewage is collected from the entire East Bay area. A predominantly residential area in Los Angeles produced 0.4 and 1.6 kilograms of PCBs daily in its liquid and sludge waste components, respectively. It is, therefore, possible that the PCB content of sludge wastes may exceed that of liquid wastes, at least on the basis of these samples. Evidently more research is needed to identify the expected daily input of PCBs in the sludge material used at both composting sites.

The amounts of PCBs introduced in the urban solid refuse component is also unknown and will depend primarily on the efficiency of the separation processes. The plastics component of urban refuse consists of 38% polyethylene, 32% polyvinyl chloride, 21% polystyrene and 9% miscellaneous plastics, like nylon and teflon.[2] In terms of PCBs, the most potentially harmful class of plastics is considered to be the polyethylene group. Since the majority of these plastics are represented by films and light containers, separation by air classification is expected to be minimal and removal must rely on screening

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[1]T. Schmidt, R. W. Risebrough and F. Gress, "Input of PCBs into California Coastal Waters from Urban Sewage Outfalls," Bulletin of Environmental Contamination and Toxicology, No. 6, 1971, pp. 235-243.

[2]N. L. Dronby, H. E. Hull and P. F. Testin, Recovery and Utilization of Municipal Solid Waste, Batelle Memorial Institute, 1971, p. 91.

after the composting process.[1] It is specified that a maximum of 1% of the compost material will be plastic,[2] and based on this assumption, as much as 700 tons may be introduced to the levee landfill site during the course of the project.

The percentage of this amount that can be expected to leach out of the landfill area is unknown, but it may have significant impact. Leachate rates can only be accurately determined if the project involves a thorough monitoring program.

Phthalate Acid Esters

Phthalate acid esters are a very widely used chemical and are commonly used in the construction, clothing, food packaging, flooring, furniture and household article industries.[3] Phthalates are widely used as a plasticizer, having recently replaced PCBs. This synthetic, organic compound is a major constituent in polyvinyl chloride plastics and apparently is an important constituent of food packages, household appliances, housewares and wall coverings.

Existing information indicates that phthalates conform to the general pattern of environmental pollutants in

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[1]An electrostatic unit to separate plastics and paper has been developed in the laboratory by the U.S. Bureau of Mines. If successfully developed on a large scale, this unit could separate all plastics from the light, air classified fraction of refuse. Resource Recovery from Raw Urban Refuse, Bureau of Mines Report of Investigations 7760, 1973.

[2]S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications.

[3]P. R. Graham, "Phthalate Ester Plasticizers--Why and How They Are Used," Perspective on PAEs, Environmental Health Perspectives, Experimental Issue No. 3., DHEW Publication No. (NIH) 73-218, 1973, pp. 3-12.

terms of stability, distribution, metabolic breakdown and toxicity. These substances have been identified in water, organic soil matter, fish and a wide variety of animals and are considered to have a ubiquitous distribution in the environment.[1]

Phthalates are apparently widespread in coastal waters[2] and in rivers draining industrial areas.[3] They have been detected in marine animals residing at great distances from pollution sources (for example, a deep-sea jellyfish).[4]

Phthalates are believed to be transported in a similar manner to PCBs.

There is general agreement in the literature that all phthalates studied to date have a low order of acute toxicity, but this is partly offset by the large background levels detected in many environments. Although the biological significance of phthalic acid residues are largely unknown, deleterious effects on reproduction have been observed in some aquatic organisms in laboratory experiments.[5] In some cases, concentrations of phthalates presently found in some waters of the United States are detrimental to aquatic invertebrates. Moderate levels have been found in fish near industrial

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[1]F. L. Mayer, D. L. Stalling and J. L. Johnson, "Phthalate Esters--An Environmental Contaminant," Nature, 1972, 238:411.

[2]E. F. Corcoran, "Gas Chromatographic Detection of Phthalic Acid Ester," Perspective on PAEs, pp. 13-16.

[3]R. A. Hites, "Phthalates in the Charles and the Merrimack Rivers," Perspective on PAEs, 1973, pp. 17-22.

[4]R. J. Morris, "Phthalic Acid in the Deep-sea Jellyfish Atolla," Nature, 1970, 227:1264.

[5]F. L. Mayer and H. O. Sanders, "Toxicology of Phthalic Acid Esters in Aquatic Organisms," Perspective on PAEs, 1973, pp. 153-157.

areas, but considerably more detailed research is required to identify deleterious effects in terms of fish physiology and reproduction.[1]

No information is available on the amounts of phthalate that would be introduced with the compost placement material. Polyvinyl chloride plastic formulations contain nearly 60% phthalate esters plasticizer content, but the separation techniques proposed are expected to extract essentially all of the heavier plastic components of the urban refuse. Laboratory analysis of the urban refuse material after separation is the only means of predicting the probable input of phthalate compounds. Furthermore the impact on biological systems can only be evaluated on the basis of a thorough monitoring program.

Heavy Metals

Heavy trace elements are natural components of the world ecosystem. Many, like zinc, copper and manganese, are constituents of essential metalloenzymes, while others (silver, lead, cadmium and mercury) have no known biological function. Natural background levels of the heavy metals in the estuarine and marine environments are poorly known, but there is widespread evidence to suggest present amounts are higher than pre-technological levels, and are responsible for inducing deleterious effects in many forms of wildlife, especially shellfish and fish.[2]

Heavy metals are introduced into river, estuarine and coastal waters via natural weathering, aerial transport, river runoff and by local discharges of industrial and domestic waters.[3] Sewage effluents are known to contain

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[1] D. L. Stalling, J. W. Hogan and J. L. Johnson, "Phthalate Ester Residues--Their Metabolism and Analysis in Fish," Perspective on PAEs, 1973, pp. 159-174.

[2] E. Browning, Toxicity of Industrial Metals (London: Butterworths, 1969).

[3] H. J. M. Bowen, Trace Elements in Biochemistry (London: Academic Press, 1966), p. 241.

high levels of some trace elements, and probably contribute significant amounts of toxic trace elements to California waterways and coastal waters.[1] The table of sewage sludge samples from the East Bay Municipal Utility District's treatment facility indicates high levels of aluminum, lead, chromium, tin, silver, titanium and nickel are in the sludge being deposited in landfills (see Table 13 following). It is not known whether these data necessarily reflect the typical composition of a sludge sample.

Heavy metals exhibit the basic properties of biological pollutants, and many species are known to selectively accumulate trace elements to many times the local environmental levels. While there is little information on the background levels of most heavy metals in estuarine organisms, more is known of heavy metal toxicity. Silver, zinc, cadmium, chromium and mercury are considered to be highly toxic to living tissues, since many interfere with oxygen metabolism, cell permeability and metabolic enzyme systems.[2] A wide range of trace elements is known to form stable metalloprotein complexes that interrupt normal cell activities. Excessive concentrations of mercury have been shown to reduce the photosynthetic rate of plankton[3] and induce adverse effects in fish and fish-eating birds.[4] The impact of trace metals on

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[1] G. R. Bradford, "Trace Element in the Water Resources of California," Hilgardia 41:45-53, 1971.

[2] E. Browning, Toxicity of Industrial Metals.

[3] [illegible] . White and R. B. Macfarlane, "[illegible] Reduce Photosynthesis by Plankton," [illegible].

[4] [illegible], et al., "Mercury in Fish and Fish-eating [illegible] Industrial Contamination in Canada," [illegible] Naturalist, 85:211-22[illegible]

TABLE 13

REPORT ON VACUUM FILTER SLUDGE CAKE

Laboratory Analysis

Ts, %	24.4
Vs, %	12.0
*NH_3-n, mg/1,000g	756 wet sample
*Total Kjeldahl nitrogen, mg/ 1,000g	7,810 wet sample (excluding nitrites and nitrates)
*Total phosphate, mg/1,000g	11,386 wet sample
Hg	0.59
Total alkalines, mg/L as $CaCo_3$	--
Volatile acid, mg/L as HA_c	--
Oil and grease	1.4
COD, total, mg/kg	187,098 wet weight
BOD, mg/L	9,000
pH	--
Carbon/nitrogen	8:1

Spectrographic Analysis
mg/1000g wet sample

Sodium	**
Potassium	496.0
Calcium	7,440.0
Magnesium	1,488.0
Silicon	principal constituent
Boron	37.2
Phosphorus	4,340.0
Manganese	124.0
Iron	8,680.0
Aluminum	6,200.0
Lead	372.0
Chromium	620.0
Tin	74.4
Copper	74.4
Silver	12.4
Zinc	744.0
Titanium	868.0
Nickel	62.0
Strontium	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

*Average of two determinations.
**Zinc interference, but approximately 2%.

Source: [illegible] Bay Municipal [illegible] District, Sanitary District [illegible]

estuarine mollusks is complex and difficult to assess but can be deleterious.[1]

It is presently impossible to make quantitative predictions of the effect of heavy metal waste disposal in the estuarine system since there are inadequate data on the chemical and biochemical processes involved and the ecological structure of local communities.[2] Predictions will have to be based on a thorough monitoring program designed to identify background and subsequent levels of the more toxic trace elements in indicator or sensitive species.

Conclusions

The potential introduction of environmental contaminants into the Delta waterway system represents the only significant and critical impact of the project on fish and wildlife. Several areas near Mandeville Island, including Bacon Island, Latham Slough and Middle River, support significant wildlife and fishery resources that would probably be adversely affected if substantial quantities of synthetic organic compounds and heavy metals escape from the compost placement site. Local waterways are known to constitute major nursery areas for the striped bass, a situation probably attributable to the favorable abundance of certain food species.[3]

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[1]C. N. Schuster and B. N. Pringle, "Effects of Trace Elements on Estuarine Mollusks," Proceedings of First Mid-Atlantic Industrial Waste Conference, University of Delaware, 1968, 6E-5:285-304.

[2]National Academy of Sciences, Wastes Management Concepts for the Coastal Zone--Requirements for Research and Investigation, Publication No. 15BN 0-309-01855-2.

[3]California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Delta, Fish Bulletin 136, 1966.

Escapement of pollutants could significantly reduce the productivity of the area.

The impact of the project will depend upon a combination of many interrelated factors, including the total amount of pollutants introduced to the site, pollutant escape and distribution, and pollutant uptake rates and accumulation by biotic elements. The toxic effects of the major pollutants are complex, and species response to toxicants will vary greatly with different stages in the life history, with previous nutrition, and with season, to mention only a few factors.

The experimental situation provides an ideal opportunity to assess the effect of this form of refuse disposal, but its success will depend upon the strength of the ongoing monitoring program. The development of adverse effects in aquatic animals should be considered a justifiable basis to terminate the program until such time "cleaner" compost materials can be used.

C. AIR QUALITY AND ODORS

The Demonstration's effects on air quality can be classified into three categories:

(1) Gases, odors and dust released during the composting process.

(2) Emissions from vehicles involved in the project.

(3) Dust and litter released during loading, unloading and levee reinforcement processes.

(4) Dust from wind erosion of completed compost surface.

Pollutants released during the composting process will only affect the Berkeley and Sierra Point sites. Gases produced by the composting material during aerobic decomposition consist almost entirely of carbon dioxide, a harmless gas which is not normally considered a pollutant. However, methane or hydrogen sulfide and other noxious gases could be generated in brief periods of improper operation until aerobic conditions could be restored.

At Sierra Point, the prevailing moderate windspeeds and southwesterly wind direction will rapidly dilute any odors and transport them over the Bay. A residential area is located one-half mile southwest of the site. Because the winds necessary to transport odors from the site to these areas are infrequent, and because compost is a relatively weak source of odors, no significant odor problem is expected at the Sierra Point site.

The Berkeley site has a greater potential for odor problems. Prevailing westerly winds could carry odors to residences east of the site. The nearest residence is approximately one mile east of the site, and the Berkeley Marina is located about three-fourths of a mile south of the site. However, the proposed site is presently part of the Berkeley landfill operation, which emits odors far more objectionable than those from composting material. Despite this, no complaints of odors have been recently recorded.[1] The composting operation is not expected to increase production of odors by a significant amount, given the present conditions; therefore, no appreciable impact from composting odors is expected.

Wind-blown particles of dust and litter are not expected to be a problem at either composting site. Despite the moderate windspeeds found at both sites, the dampness of the composting material and the enclosure surrounding the site would prevent materials from escaping and becoming a nuisance.

Another impact on air quality is due to vehicles involved in the project. At the Sierra Point site, these vehicles include trucks bringing refuse from the transfer station to the site, vehicles used in the composting process, and a tugboat used to transport the compost to the Delta. Pollutants emitted by trucks transporting the refuse will actually decrease due to the project. Refuse is currently taken from the San Francisco transfer station to a sanitary landfill area in Mountain View, approximately 35

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[1]Personal communication with Jay Schmitzer, Air Pollution Inspector, Bay Area Air Pollution Control District, October 29, 1973.

miles to the south. The Demonstration project will divert about six truckloads per day to the composting site which is two miles from the transfer station. Vehicle emissions will be reduced by an approximate 400-mile decrease in vehicular mileage per day.

Pollutants emitted by diesel-powered composting and yard vehicles and the tugboat will be insignificant, due to their small number and intermittent use.

In Berkeley, 46 truckloads a day will deliver raw refuse to the transfer station for processing and about 8 trucks will transfer refuse to the composting site. The change in amount of emissions is unknown since the transfer station site has not been selected, but it is expected to be negligible. As at Sierra Point, no significant effect on air quality is expected due to the composting vehicles and the tugboat.

Vehicles at the Mandeville Island site include a dump-truck, a scraper, a bulldozer, a water wagon and a crane. Emissions from these five vehicles will not be significant.

The loading and unloading operations at all three sites may cause blowing dust and litter. At the Berkeley and Sierra Point sites, flying debris can be minimized by use of a canvas chute for loading into the barge and by moistening the compost prior to loading. Another method might be to limit loading operations to the morning hours when windspeeds are generally lowest, or load only when windspeed is below a critical level which is to be determined by experience.

Windblown dust from the unloading operation and levee placement process at Mandeville Island could cause significant problems. Present plans call for unloading by a crane with a clamshell bucket into a dumptruck. This method has great potential for dust problems. Methods for combating this problem are similar to those used at the composting sites. The compost in the barge can be watered as it is unloaded, and restrictions can be set up regarding acceptable wind conditions for unloading. Another possible solution is the use of a covered conveyor to unload the compost from the barge.

Another possible problem is blowing dust due to wind erosion of the compost fill at Mandeville Island. The effect of wind erosion on air quality will be measured by the air quality monitoring program to determine the wind erodibility characteristics of compost relative to peat soil.

D. NOISE

Noise at all three sites will be increased, mainly by vehicles involved in the project. The noise environment at Sierra Point and Berkeley sites will be affected by the trucks delivering the refuse, the equipment used in the composting process, and the equipment used in loading the barge. These sources are small and intermittent compared to the neighboring freeways and railroads already present. Both sites are relatively distant from noise-sensitive areas and are well isolated from the general public. For these reasons, no significant impact due to noise is expected at these sites.

New noise sources at Mandeville Island include a crane, dumptruck, scraper, bulldozer and water wagon. Due to the agricultural use of the surrounding land and long distances to residences, the increased noise level should not have a significant impact.

E. LAND USE

The "Delta Master Recreation Plan"[1] offers a recreation and environmental policy plan for the Delta. It classifies Delta waterways by categories to denote the principal types of uses consistent with the waterways' capacity for accommodation of such uses. "They are intended as planning guides for the purposes of maintaining and furthering the trust purposes. Case-by-case analysis will still be required in determining allowable uses of these waterways in the long-term statewide public interest."[2] The

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[1]California State Resources Agency, Delta Master Recreation Plan, February 1973.

[2]California, Delta Master Recreation Plan, p. V-ii.

Demonstration's barge-unloading facility would not conform to the plan's "natural use channel" designation of the adjacent waterway. This classification denotes areas exhibiting outstanding scenic, aesthetic and wildlife values which should be preserved and does not permit new structures or improvements of any kind in or over the waterway. This site was selected due to other overriding considerations and would have to receive special consideration in the permit approval process.

The Demonstration's use of the Mandeville Island site would remove the area landward of the levee from commercial agricultural production for a period of perhaps three to five years. The actual compost placement operation would require two years, with the remaining one to three years needed for development of the compost into a productive soil mantle.

Both the Berkeley and Sierra Point composting operations would be temporary land use changes of the sites. They could both revert to their undeveloped states at the completion of the project.

F. VISUAL QUALITIES

1. Berkeley

The major visual impact of the composting site at the Berkeley landfill would be the barge-docking facility and the screened enclosure around the composting activities. The 25-foot high structure would consist of a wire mesh netting supported by cables with solid walls approximately 12 feet high. The 12-foot wall would block direct views of the composting operation, and the screening would tend to contain any airborne matter within the structure. The addition of landscaping as visual screens would be considered and would enhance views of the structure. If care is taken with the barge-loading operation, it could be considered a visually interesting waterfront activity.

The composting structure and related vehicular activity would be visible from the Berkeley hills to the east and the hotel complex to the south. The Demonstration could also be viewed from Point Flemming and Golden Gate Fields to the north. Views from Highway 80 would be minimal because of highway landscaping.

2. Sierra Point

The visual quality of the composting site at Sierra Point would be altered by the addition of a barge-loading dock and composting structure similar to that planned for Berkeley. The proposed site would no longer be vacant, and the addition of landscaping would enhance views of the structure. The composting structure and related vehicular activity would be visible from the industrial park and shipping channel to the south and portions of the Bayshore Freeway and Bayshore Boulevard to the west. The site would not be visible from any residences except for a few in the easternmost portion of South San Francisco across the freeway.

3. Mandeville Island

The Demonstration would alter visual experiences on a small portion of Mandeville Island. Additions to the agricultural landscape would include a crane mounted on a pier for barge-unloading operations, a short concrete pad on the levee, and an access ramp mounted on a trestle extending into the island. One small administrative office structure, possibly a trailer and a graveled parking area, would also be added.

The changing topography from the berm construction would not appreciably alter the visual quality of the site. Because Mandeville Island is an agricultural area, it is likely that the compost placement operation would not be visually obtrusive. The compost should appear similar to peat soils, and earth-moving activities would not be much different from normal agricultural operations. The barge-unloading operation, being nearly continuous over a two year period, would visually intrude on an otherwise natural waterway. However, barging operations for levee maintenance are common throughout Delta sloughs, and the barging for the Demonstration would not appear out of place.

G. WATER QUALITY

Water quality is an important consideration in any large-scale solid waste disposal program and is also a critical factor when considering any alterations of the Delta.

While the Delta's water problems have been the subject of concern and study for several years, there is currently little information on the impact upon water quality from composted municipal refuse and sludge. It is therefore one of the primary functions of the Demonstration to gather information and evaluate any potential water quality hazards that might result from a large-scale project. Nevertheless the water pollution potential of the Demonstration itself must be considered.

Various stages of the Demonstration which could potentially impair water quality are:

1. Leachate from the compost operations at Berkeley and Sierra Point.

2. Barge-loading and unloading operations.

3. Leachate from the compost berm behind the levee.

4. Possible dredging operations at Sierra Point and Berkeley that might be necessary to accommodate barges.

The primary concerns are heavy metal toxicity, pathogen survival and possible long-term effects from trace substances in the plastics remaining in the compost.

1. <u>Composting Operation</u>

The benefit of composting refuse and sludge before land application is that it (1) stabilizes nitrogen that might otherwise get into streams or drinking water, (2) destroys pathogens and weed seeds and (3) eliminates odors.[1]

The material to be composted will consist of the light organic portion of municipal refuse (after shredding and air classification) and sewage sludge. Although metals, glass, heavy plastics and other materials would be removed from the refuse, some light plastics would remain.

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[1]J. Goldstein, "USDA Speaks Up for Municipal Composting," Rodale's Environment Action Bulletin, October 13, 1973, p. 5.

The refuse-sludge mixture provides a more optimum carbon: nitrogen ratio for composting, because refuse has a high C/N ratio (100:1) and sludge a low C/N ratio (around 10:1).[1] Municipal sewage sludge, however, can contain appreciable amounts of heavy metals. The amount is a function of the industrial input into the system and can vary considerably.[2]

During composting, a leachate will be produced, principally water and dissolved mineral salts. The amount of heavy metals in the leachate will depend upon the quantity in the original material, the pH of the compost and the stage of composting. The pH varies during the course of composting and heavy metals form an insoluble complex at pH levels above 7 but will leach out at pH below 7.[3]

The leachate from the Demonstration will be contained. The composting would occur on a paved surface, and the rain and drainage water will flow to a holding area. This drained water would be stored and recycled as needed to moisten the composting refuse. Questions involving compost which need further research in addition to the fate of heavy metals are the survival of viruses and long-term effects of composted refuse and sludge on soils, groundwater and crops.[4]

After composting, the material should reach a relatively stable state (the determination of stability or maturity of the compost is somewhat relative). Indicators of this

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[1] R. Braun, "The Utilization of Refuse and Sewage Sludge by Means of Composting," Communication No. 166, Federal Institute for Water Supply, Federal Institute of Technology, Zurich, p. 13.

[2] Conversation with Dr. C. Golueke, research biologist, Sanitary Engineering Research Laboratory, University of California, Berkeley, November 6, 1973.

[3] Ibid.

[4] S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications, p. 24.

stage include appearance and odor, final drop in temperature, self-heating capacity and amount of decomposable and resistant organic matter.[1] The desired degree of stability is one in which the compost would not give rise to any nuisances when it is stored,[2] although it may still contain appreciable amounts of heavy metals and other resistant toxic materials. Materials such as PCBs would not be affected by composting. Given the present hazardous materials disposal regulations, it is unlikely that much of this would reach the municipal treatment system, except through occasional household disposal, and these concentrations would not be high. Plastics remaining in the compost also offer a potential long-term hazard to fish and wildlife (see Fish and Wildlife section).

2. Barge-Loading and Unloading

Little spillage of compost into the water is expected during loading operations, although some spillage may occur during unloading.

Owing to the "stabilized" condition of the material, no nuisance conditions are expected from limited amounts of spillage. (This is assuming no gross amount of material would reach the water.)

3. Compost Berm

The major water pollution potential of the Demonstration is in the Delta. It must be stressed, however, that use of refuse--sludge compost for agricultural purposes--is not a unique idea.

The effects of land application of compost have been extensively studied in Europe and the U.S.[3] However,

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[1]C. G. Golueke, Composting, p. 7.

[2]Ibid., p. 42.

[3]R. Braun, The Utilization of Refuse and Sewage Sludge by Means of Composting.

this study has been to examine the compost for its crop enhancement capabilities with some studies of crop uptake of heavy metals rather than for its water quality impacts. Most of the research is quite positive although points out that the potential long-term impacts of heavy metals buildup need further study.[1,2] A few researchers are more skeptical. One report indicated that "compost made from garbage contains poisonous heavy metals and chemical compounds, such as benzpyren and benzflourioles, which are found as cancer-causing agents."[3] Another noted that,

> Using sewage wastes in agriculture will not solve any disposal problems, but may give rise to new problems if the application is not based on detailed knowledge of the composition and properties of the wastes, together with knowledge of the biological and geochemical processes at work during decomposition. If cultivated fields are to be used for the disposal of sewage sludge or other wastes from urban areas, the rate of application should be based on the content of potentially hazardous components, whereby the plant nutrient and soil improvement aspects will be of secondary importance.[4]

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[1]J. C. Duggan, "Utilization of Municipal Refuse Compost," Compost Science, March-April 1973, pp. 24-25.

[2]D. A. Mays, G. L. Terman and J. C. Duggan, "Municipal Compost: Effects on Crop Yields and Soil Properties," Journal of Environmental Quality, January-March 1973, pp. 89-92.

[3]Wagner and Siddigi, article in Nature Science, Max Planck Institute Monthly, Geissen, West Germany.

[4]A. Anderson and K. O. Wilsson, "Enrichment of Trace Elements from Sewage Sludge Fertilizer in Soils and Plants," Ambio, October 1972.

These problems relate directly to the water quality aspect of the Demonstration because of the sensitive nature of the Delta environment. Rainwater, irrigation water and natural seepage could leach pollutants from the compost into the island's drainage ditches. Drainage from the ditches is pumped into Connection Slough at a point three-quarters of a mile from the Demonstration site.

No definitive answer regarding water quality impacts can be given because of the lack of research on compost leachate. The formation of the leachate is dependent upon the presence and movement of water through the compost. The quantity of leachate is dependent on the water budget, applied water, run-off, infiltration, evapotranspiration, and changes in moisture retention by the soil and compost. The quality of the leachate is dependent upon the type of materials leached.[1] The dilution factor of the drainage water and Delta water would have a significant mitigating effect, but its magnitude is unknown.

The foregoing comments on water quality are intended to identify the potential environmental effects of a long-range program involving a major portion of the solid wastes of the region.

The Demonstration and its extensive monitoring activity would provide needed information without subjecting the Delta itself to risk of serious impairment. The Demonstration is considered to be of small enough scale (total coverage over the two-year period would be roughly 20 acres out of a total of 5,500 acres on Mandeville Island and 500,000 acres in the Delta) to test the feasibility of the project and yet not cause significant deterioration of water quality in the Delta should adverse effects be detected.

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[1]California Department of Water Resources, Sanitary Landfill Studies, Bulletin No. 147-5, July 1969, p. 29.

The Central Valley Regional Water Quality Control Board has reviewed and provided input to the proposed monitoring program, although formal application for permit approval has not yet been made.

4. Dredging

A small amount of dredging may be needed at the barge-loading and unloading docks, but channels appear to be deep enough to accommodate loaded barges at high tide so that resulting water quality impacts should be negligible.

H. SOCIOECONOMIC IMPACTS

At Mandeville Island approximately 15 to 20 jobs would be created for barge-unloading and compost placement operation and monitoring activities. Research, construction and operation contracts would be spread over a wide area, having little or no economic impact on any particular geographic location. In Berkeley, operation of the transfer station, the composting operation and barge loading would generate approximately 20-25 new jobs. Considering the size of the local labor force, the impact of these new jobs will be small. At Sierra Point, operation and maintenance of the composting station and the barge-loading facility would create employment for approximately 20 workers. Again, the economic impact of these new jobs is positive but small.

Careful siting of the Berkeley transfer station in the industrial area of the city should result in minimal adverse impacts on neighboring industrial or residential areas. Particular attention should be paid to the routing of collection vehicles through residential areas. The remote location of the composting sites at Berkeley and Sierra Point should result in no negative social impacts.

It is proposed that 10% of the total project cost of $6.8 million be shared by 11 counties of the Bay Area. It is expected that each county will be assessed its share of the total cost on the basis of population. The cost per year may range from $3,000 for smaller counties up to $45,000 for the larger counties. These projections are low enough not to have adverse impacts on the fiscal condition of any of these counties.

I. UTILITIES

On Mandeville Island, the Demonstration would require electrical power to operate test equipment, lighting and small appliances at a trailer headquarters, but the amount would be insignificant. No alterations of the island's power system would be necessary.

Electricity for the Berkeley compost site would be used to operate electrical repair equipment, lights and small appliances. These amounts are not large enough to be significant, although a short extension of utility lines may be required.

It is estimated that the Berkeley transfer station annually would require 429,000 kilowatt hours (KWH) of electricity assuming a power requirement of 11 KWH/ton of refuse. A slightly larger power requirement may be needed, depending on the extent of resource recovery equipment installed. This need is not large enough to cause a significant impact on existing power distribution systems in the city. Water needs for the transfer station will be very small.

The composting operation will require larger amounts of water--perhaps 50,000 gallons per day, although rainfall and leachate recycling could substantially reduce this figure.

At Sierra Point there are no utility lines near the compost site, so new lines would have to be installed. Estimated cost for new water and electrical service connections is $60,000.

J. HEALTH AND SAFETY

The following aspects of the Demonstration were evaluated for potential health and safety:

- Pathogen survival
- Flies breeding in composting area
- Enhancement of rodent problems
- Combustibility of compost
- Gas production in compost berm (Mandeville Island)
- Contamination of well-water

Several of these potential problems can be avoided by adherence to the recommendations for the operating specifications for composting.[1]

No health hazards from pathogens have been reported in connection with composting. The high temperatures (up to 60°C) reached within the compost pile and the antibiotic reaction of other organisms are responsible for destroying common pathogens.[2] This is dependent, of course, upon proper management of the composting process--i.e., proper turning of the windrows so that all sections are exposed to the high interior temperatures. The question of virus survival in composting has not been researched as yet.

Fly development is also a problem that can be avoided by proper management. The composting specifications indicate that a paved surface and frequent complete turning of the windrows should be adequate to eliminate any larvae production. However, chemical measures could be utilized if necessary. Once compost reaches a "stable" condition, it no longer contains the nutrient sources flies require and would not present any problems.

Although rats are a problem in waterfront areas, the panel surfaces of the yard enclosure and frequent turning of the compost would prevent any burrowing and establishment of rodents within the refuse-sludge material. Again, once this material is composted to a stable condition, as it would be before being barged to the Delta, it would no longer provide a suitable or nutritious habitat for pest rodents.

A combustibility test[3] on a sample of very dry compost showed it to be combustible. This indicates that compost,

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[1]S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications (see Volume III).

[2]C. G. Golueke, Composting, p. 67.

[3]A lighted cigarette was placed on top of the compost, and by fanning the cigarette the compost ignited and smoldered.

when wind-dried on the surface of the compost berm, would be subject to combustion, although probably no more so than the existing peat soils.

Gas production in the compost berm on the island would not occur with proper composting, because the compost would not undergo further decomposition except for possible surface oxidation.

Fresh-water (drinking) wells located near the Demonstration site on the island are cased to a depth of 100 to 130 feet and therefore would not be subject to contamination from leachates.

K. SOLID WASTE OPERATIONS

The Demonstration would have a significant impact on solid waste operations in Berkeley since it would process all municipally collected wastes. Depending on the shredding equipment selected and the degree of screening, some residual material would require disposal in a landfill. This material is estimated to be a maximum of 20% of the incoming refuse, or 30 tons per day. This would reduce by 80% what Berkeley delivers to its landfill and would result in an overall reduction of 25% of refuse delivered to the landfill. Based on these projections, the project would extend the life of the present landfill from one year to three years.

The existing transfer station in San Francisco processes 2,000 tons per day of raw garbage; the Demonstration would divert 150 tons per day of this load. Considering the residual material requiring disposal from the composition operation, this would result in about a 6% reduction of material delivered to the Mountain View landfill site, a relatively negligible effect.

L. TRANSPORTATION

1. Vehicles

Vehicular traffic on Mandeville Island would increase somewhat due to employees working at the test site, health and other inspectors, and visitors. About 2 1/2 miles of levee road from the bridge to the site would require graveling for winter use.

In Berkeley municipal route trucks would deliver refuse to the transfer station. Transfer trucks would then take composting material to the composting site five days per week. Because of the relatively heavy traffic usage at the transfer station, the city should locate the transfer station for easy access. The expected

traffic volume into the station is 46 trips per day from city route trucks and, if needed, 17 trips per day from Oakland Scavenger trucks. Approximately eight transfer truck trips per day are expected from the transfer station to the composting site. Transfer trucks carry more volume than route trucks so that a slight net reduction in mileage may be realized between city streets and the composting site.

The existing major vehicular corridors along Gilman Street, University and Eastshore avenues should adequately service the transfer route to the landfill composting site. The proposed transportation route from the San Francisco transfer station to the compost site at Sierra Point, approximately two miles away, would be along a private dirt road adjacent to the Bayshore Freeway (Highway 101). Eight trips by 18-ton capacity, 40-foot self-dumping trucks would be required daily.

The proposed trucking from San Francisco to Sierra Point would reduce the total distance otherwise traveled to the Mountain View landfill by about 400 truck miles per day. In addition, trucks using the dirt road would not disturb public throughways or residential areas. The highway landscaping obscures these trucks from the view of motorists on the Bayshore Freeway.

2. Barging

One 600-ton barge per week would transport compost from each composting site to Mandeville Island. Figure 8 indicates the route up the San Joaquin River, across Frank's Tract, through deepwater channel and Middle River to the east side of Mandeville Island. Wave generation from barges is small due to their slow rate of travel so that wave erosion to Delta levees is expected to be minimal. The two barge trips per week should have no significant impact on the existing Delta waterway traffic.

The current barging operations in the adjacent Delta waterways indicate that no dredging should be needed except possibly some small amount at the unloading dock. Any dredging would cause a temporary but insignificant disturbance of the water.

The proposed barging in Berkeley would be from a site on the north face of the waterfront area bordering the land-fill site. The water should be deep enough (6 feet at lower low tide) in this area for barging without dredging, although a small amount of dredging may be necessary for a "bathtub," or hole, at the dock. The 70-mile barge trip from Berkeley to the island would be made once a week.

A temporary breakwater would be required to protect the barging operation at the Berkeley site. The most effective and least expensive breakwater would be earthfill, which could be constructed from clean fill brought to the landfill site. It would extend 150 feet perpendicular to the land, rise 25 feet in height and be 20 feet in width at the apex. About 10,000 cubic yards of fill would be needed. Broken concrete would probably line the western exposure to reduce wave erosion.

Earthfill breakwaters are less desirable than wooden breakwaters on a long-term basis because they are more easily eroded and construction and removal would cause local turbidity.

The deep, calm and protected channel bordering the southern edge of Sierra Point should not require dredging for barging operations. The waters bordering the site are 10 feet at lower low tide, and Oyster Channel leads to the site at a lower low tide depth of 5 feet for 150 feet.[1]

Minor dredging adjacent to the wharf for the barge may also be required here. The barge would move once a week from Sierra Point to Mandeville Island, a distance of about 80 miles each way. The limited movement should have little adverse impact on existing channel traffic.

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[1] U.S. Coast and Geodetic Survey Map No. 5527.

VI. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Adverse environmental effects of the Demonstration that cannot be avoided include settlement and cracking along an 1,800-foot stretch of levee and possible leaching of contaminants from the compost berm.

The extent to which each would occur cannot be determined precisely and, as has been mentioned previously, the monitoring program during the Demonstration would provide information on the degree of these effects.

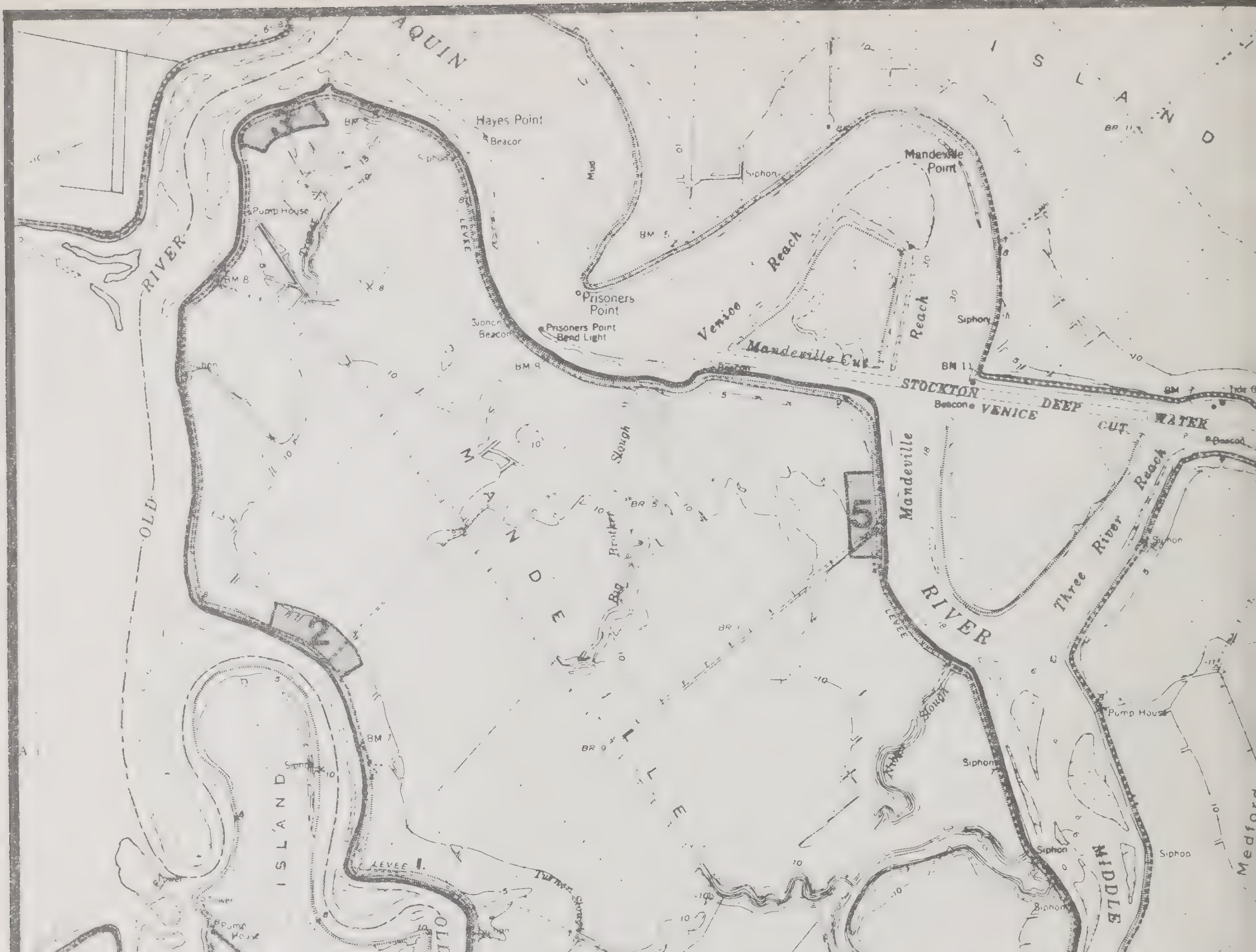
VII. MITIGATION MEASURES PROPOSED TO MINIMIZE ENVIRONMENTAL EFFECTS OF THE PROJECT

The small scale of the Demonstration, its extensive monitoring program and several design features are mitigation measures incorporated in the project to minimize environmental effects.

The Demonstration would use less than 1% of the Bay Area's wastes and would only last for two years, during and after which the results would be carefully evaluated. Only 20 acres--of the 5,500 on Mandeville Island and 500,000 in the entire Delta--would be utilized.

Field observations of pore pressures, settlements and horizontal movements are included in the monitoring program to measure and assess the physical effects of the compost berm on the levee. Monitoring would be conducted on input refuse and sludge material, and on leachates from the composting operations and the compost berm to determine water quality and biotic effects. Air pollution and agricultural monitoring would also be conducted.

Mitigating design features of the project include air classification and screening of plastics and metals from the incoming refuse, a screened enclosure and capture of leachates at the composting yard, the drainage system under the berm to minimize water pressures, and slow construction of the berm using gradual slopes.



Alternative Island Sites

Figure 12

Bay Delta Resource Recovery Demonstration Project

eip / ABAG

VIII. ALTERNATIVES

A. NO PROJECT

If the project were not conducted, the feasibility of reinforcing Delta island levees with composted refuse and improving island soil quality could not be explored unless another similar project were proposed. Other methods would ultimately have to be developed to preserve the Delta islands, and Bay Area communities could not develop this option for disposal of organic solid wastes.

B. ALTERNATE WASTE SOURCES

An important principle in the selection of source material was that refuse disposal is primarily a responsibility of government. As such, offers for source material were solicited from governmental units rather than privately franchised disposal operators, although the two often work closely together.

Other waste source candidates that were evaluated included Palo Alto, San Leandro, Oakland, San Joaquin County and a joint proposal from Antioch, Pittsburg, and Brentwood.

The key criteria used to evaluate the candidates were:

Sufficient quantity of refuse and sludge
Availability of a composting site
Endorsement by the governmental unit
Political and geographic regionality
Degree of community interest
Net cost to the Demonstration

The Pittsburg-Antioch-Brentwood area was not selected because of an insufficient refuse supply. The San

Joaquin County proposal came from the voluntary Countywide Solid Waste Management Committee and did not have the official endorsement of the County Board of Supervisors. The San Leandro, Oakland and Palo Alto alternatives did not fail to meet any specific criteria but did not offer proposals as strong as those from the cities finally selected.

C. ALTERNATE ISLANDS

Other islands considered for the Demonstration site included Lower Jones Tract, Bradford Island, Orwood Tract, Woodward Island and Jersey Island. Islands were evaluated based on the following criteria:

- Owner interest in levee reinforcement using compost
- How typical the soil and levee conditions were of the Delta
- Ease of accessibility by barge or rail
- Lack of objections from neighboring landowners

On the basis of these criteria, Mandeville Island was judged to be the best overall site for the Demonstration project. First, the island is under single ownership, which simplifies the problem of objections from neighboring landowners. Second, the levee conditions were felt to be serious enough, yet not so severe as to cause unwarranted risks of conducting the Demonstration. Third, the island can be reached conveniently by barge. Finally, Al Zuckermann, the island owner, has a high interest in experimenting with levee reinforcement using compost.

D. ALTERNATE SITES ON MANDEVILLE

The sites initially selected by Mr. Zuckermann as possible locations for the project are shown in Figure 12. Sites 1 and 2 were rejected because levee conditions were not as secure as at the other sites. Sites 3 and 5 were rejected primarily because of their distance from the Mandeville Island bridge--seven miles and five miles, respectively. Contractors will need to drive onto the island daily, and visitors are expected to frequent the site.

Minimal driving distance on the levee roads is important to avoid interference with farming operations and because of severe mud problems that disrupt vehicular traffic during winter rains. Site 5 is also in the middle of a pheasant game preserve and would cause greater disruption to nesting fowl than Site 4, the site selected.

E. OTHER METHODS

It should be recognized that the Demonstration is a research project to test a possible future system for solid waste utilization. Regardless of the success or failure of the Demonstration as a whole, many of the processes developed would be useful conponents in an alternative system.

1. Landfills

The many small dumpsites in the Bay Area do not qualify as long-term alternatives to the solid waste disposal problem because of their limited capacity and environmental considerations. However, there are three major long-term landfill proposals currently under consideration by local and county governments.

a. Potrero Hills Landfill

Envirosol, a Seattle-based land development company, has made a preliminary proposal to use a 900-acre canyon in the Potrero Hills north of Suisun Marsh as a regional landfill. The project does not propose to alter the jurisdiction or contractual agreements that are currently in operation on the local level. Rather, it calls for an unspecified number of regional processing/transfer stations similar to the one in San Francisco. At each of these stations, raw refuse would be compacted and then shipped via barge to dock facilities near the site. Trucks would then haul the compacted refuse to the site. The volume of the dumpsite is estimated to be 114 million cubic yards and could theoretically serve as a landfill for the

nine Bay Area counties and Sacramento and San Joaquin counties for 125 years.[1]

The Potrero Hills project is basically a disposal operation and does not directly address the questions of resource recovery from solid wastes or regional management of solid wastes. The project is currently being reviewed by the Solano County Planning Commission.

b. Ox Mountain Landfill

This 2,100-acre site, proposed by San Mateo County Scavenger Company, is located north of State Highway 92 and west of Skyline Boulevard in San Mateo County. The site consists of two steep narrow canyons, one of which has been partially prepared for use as a dumpsite. The proposed fill would cover approximately 200 acres of the site to a depth of several hundred feet and is estimated to have sufficient capacity to serve the needs of San Mateo County until the year 2000.

So far, this site is intended to serve only residences and industries in San Mateo County. This is a conventional sanitary landfill, and resource recovery is not anticipated.

Implementation of this proposal would require the improvement of State Highway 92 to freeway status. The State Division of Highways has postponed this project to 1981 at the earliest, and considerable opposition to improvement has already been expressed by local residents.

c. Kaiser-Radum Land Reclamation Project

This project is proposed by Kaiser Sand & Gravel Corporation to reclaim a 775-acre quarry site near the city of Pleasanton (within Alameda County jurisdiction)

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[1]Solano County Planning Commission, Draft Potrero Hills Environmental Impact Report, July 5, 1973, prepared by Wilsey & Ham with Cooper Clark & Associates, Wildlife Associates, and William C. Ellis, Groundwater Geologist.

as a regional sanitary landfill. Over a four-year period, 20-acre modules would be filled with solid waste and later would be covered with excess overburden. The site would then be available for alternate land use.

Serious questions with regard to possible contamination of local groundwater reserves have been raised by local groups and the State Water Quality Control Board. On October 4, 1973, the State Board reviewed the project and ruled that the site could only be filled to a depth of 40 feet, thus reducing the capacity of the site by more than 50%. No decision has been announced by Kaiser officials as to their next move.

d. Rail Transport to Areas Outside the Bay Area[1]

In 1969 Western Pacific Railroad made a proposal to the City of San Francisco to haul their municipal waste by train to Lassen County in Northern California. The proposed system called for a special unit train for transporting the refuse to rural parts of Lassen County and possibly to Nevada. Both areas have an almost unlimited capacity to accept wastes for landfill. However, this proposal was abandoned because of its high cost and political considerations. Unless a new proposal is forthcoming which includes resource recovery and a reclamation program, it appears unlikely that this proposal would be a viable disposal practice.

2. Energy Production

a. Incineration

Utilization of municipal solid waste as a source of energy for generating electricity is widely used in Europe but is only in limited use in the United States. In the Bay Area, all PG&E plants are run on natural gas or oil and are unable to use municipal waste as fuel. However, several local firms have developed systems for energy production based on incineration.

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[1]Commonwealth Club of San Francisco, What Method of Solid Waste Disposal Should be Used in San Francisco? Part Two, Volume LXIII, No. 51, December 22, 1969.

Combustion Power Corporation of Menlo Park has been developing a gas turbine power generation system fueled with processed municipal solid waste. This method is compact, offers flexibility of location, and can recover metal and glass from the solid waste stream.

The CPC system could be complementary to the system proposed in the Demonstration since rubber and plastic are not compostable but do have very high heat content. However, the CPC system is still in the development stage and its limited daily capacity of 150 tons per unit may preclude its use as a general solution to waste disposal problems in a large metropolitan region.

The Sira Corporation of Los Gatos has developed a system for processing refuse to separate glass and metals from the combustible fraction which is used as fuel in conventional power plants. The combustibles are subjected to heat and pressure to produce either pellets or "dense logs" which have a heat content of about 7,000 BTUs per pound. The system is in the development stage and is being actively marketed by the firm.

b. Pyrolysis

Destructive distillation, called pyrolysis, was adapted from its use in manufacturing coke and charcoal to its current application for reduction of municipal solid wastes. Several commercial systems have been designed by such companies as Monsanto, Garrett and Union Carbide, and the process has been thoroughly studied by the U.S. Bureau of Mines. Similar to the incineration process, pyrolysis operates at high temperatures and can produce fuel gas and oil or be utilized to generate steam. No fully operational systems have yet been installed in this country.

IX. RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM ENHANCEMENT OF THE ENVIRONMENT

The concept of the Demonstration is the short-term use of the 20-acre site on Mandeville Island to demonstrate on a small scale the feasibility of compost placement as a levee reinforcement and soil-building material. Even on a small scale, the Demonstration involves some site impairment and risks. The Demonstration would remove the 20-acre site from agricultural production for a minimum period of two years, although agricultural productivity experiments may be conducted during this time. The time required for the compost berm surface to stabilize, mature and become agriculturally productive is not known and would be one of the many questions answered by the Demonstration.

The long-term opportunity of the Demonstration, if successful, would be to provide the basis for regional application of this method of protecting Delta islands. The primary benefit of widespread application of this system would be the preservation of valuable agricultural lands by reinforcing levees to prevent island inundation and by eventually raising the level of the island interior with compost, reversing or at least halting current land subsidence problems due to bio-oxidation. Another benefit would be the enhancement of Delta water quality by reducing the probability of levee breaks. Severe levee breaks result in saline intrusion that is damaging to freshwater fisheries, agricultural production and important domestic water supplies of the Delta. Secondary long-range benefits would include the enhancement of recreational wildlife use of the Delta.

On a regional basis, the environment would be enhanced by the reuse rather than disposal of municipal solid waste components. Valuable resources such as metals and organic materials would not be lost but would be reintroduced to the natural resource stream. This would reduce degradation of the environment while preserving invaluable agricultural lands and natural resources.

Risks involved in the Demonstration include possible air quality degradation due to increased particulate generation, water quality degradation due to leachate from the compost that could also seriously damage fisheries in the immediate area, settlement and cracking of the levee and, in the extreme, a possible break in the levee and inundation of the island.

X. IRREVERSIBLE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The only irreversible environmental effect of the project would be the placement of a berm behind 1,800 feet of levee on 20 acres of Mandeville Island. Composting operations at both Sierra Point and the Berkeley landfill are intended to be temporary; therefore, the commitment of land to these operations would not be irreversible, and they could revert to their previous state at the end of the Demonstration.

XI. GROWTH-INDUCING IMPACTS

The temporary growth-inducing impacts of the Demonstration would be limited to a small increase in local employment on Mandeville Island and in Berkeley and South San Francisco.

If the Demonstration proves successful and a full regional system is initiated, there would be three potential growth-inducing impacts. They are:

1. Stabilization of the levees that currently protect Delta islands could provide the necessary assurance of safety that would increase the likelihood of non-agricultural development of the area. This type of development has already occurred in eastern Contra Costa County. The likelihood of commercial or recreational development would require careful land use planning to guarantee the preservation of those qualities of the Delta felt to be most valuable.

2. Full-scale regional resource recovery operations would allow for expansion of the secondary materials market. Currently, inconsistent supplies have hampered expansion of processing facilities due to high capital investment costs. However, a regional resource recovery operation would provide a consistent supply and would make capital outlay for facilities and equipment economically justifiable.

3. An effective system of mechanical resource recovery and environmentally sound disposal could tend to reduce the public's concern about decreasing the quantity of solid waste generation.

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